US010528013B2

(12) **United States Patent**
Piaskowski et al.

(10) **Patent No.: US 10,528,013 B2**
(45) **Date of Patent: Jan. 7, 2020**

(54) **SYSTEMS AND METHODS FOR INTERFACING WITH A BUILDING MANAGEMENT SYSTEM**

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(73) Assignee: **Johnson Controls Technology Company**, Auburn Hills, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 128 days.

(21) Appl. No.: **15/593,898**

(22) Filed: **May 12, 2017**

(65) **Prior Publication Data**

US 2017/0329292 A1 Nov. 16, 2017

Related U.S. Application Data

(60) Provisional application No. 62/336,520, filed on May 13, 2016.

(51) **Int. Cl.**

G06F 19/00	(2018.01)
G05B 15/02	(2006.01)
H04L 12/28	(2006.01)

(52) **U.S. Cl.**

CPC ***G05B 15/02*** (2013.01); ***H04L 12/2809*** (2013.01); *G05B 2219/2642* (2013.01)

(58) **Field of Classification Search**

CPC G05B 15/02; G05B 2219/2642; H04L 12/2809

See application file for complete search history.

(56) **References Cited**

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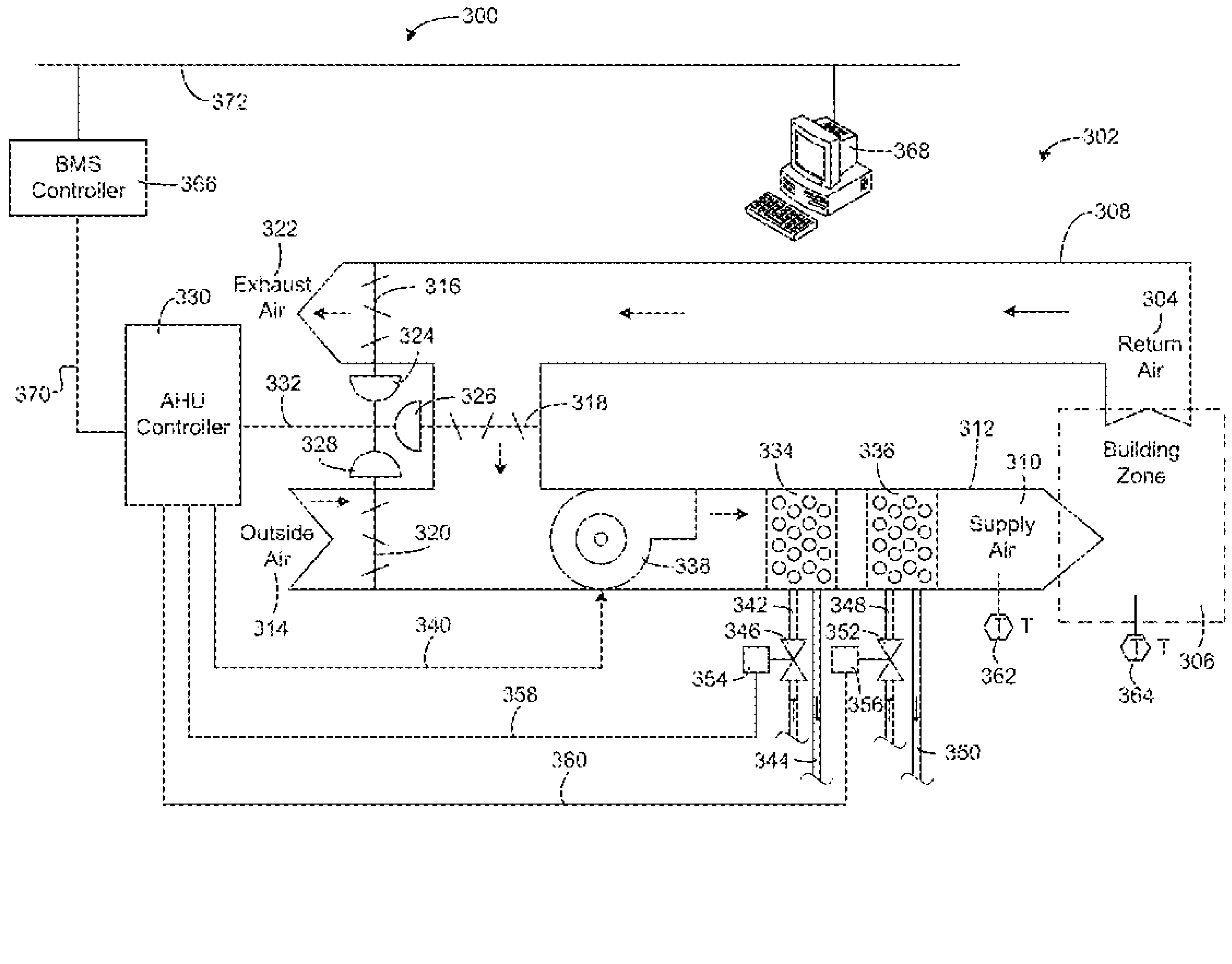
* cited by examiner

Primary Examiner — Michael D Masinick
(74) *Attorney, Agent, or Firm* — Foley & Lardner LLP

(57) **ABSTRACT**

A building management system (BMS) interface system. The BMS interface system includes a user interface and a BMS controller in communication with the user interface. The BMS controller includes a processor. The processor is configured to display a graphical scheduling interface on the user interface and receive a scheduling input from the user interface. The processor is further configured to extract one or more scheduling elements from the received scheduling input and convert the scheduling elements into one or more BMS data objects. The processor is further configured to update the graphical scheduling interface displayed on the user interface. The processor is also configured to execute one or more scheduling instructions based on the received scheduling input, wherein the scheduling instructions are associated with the operation of one or more BMS devices.

20 Claims, 26 Drawing Sheets



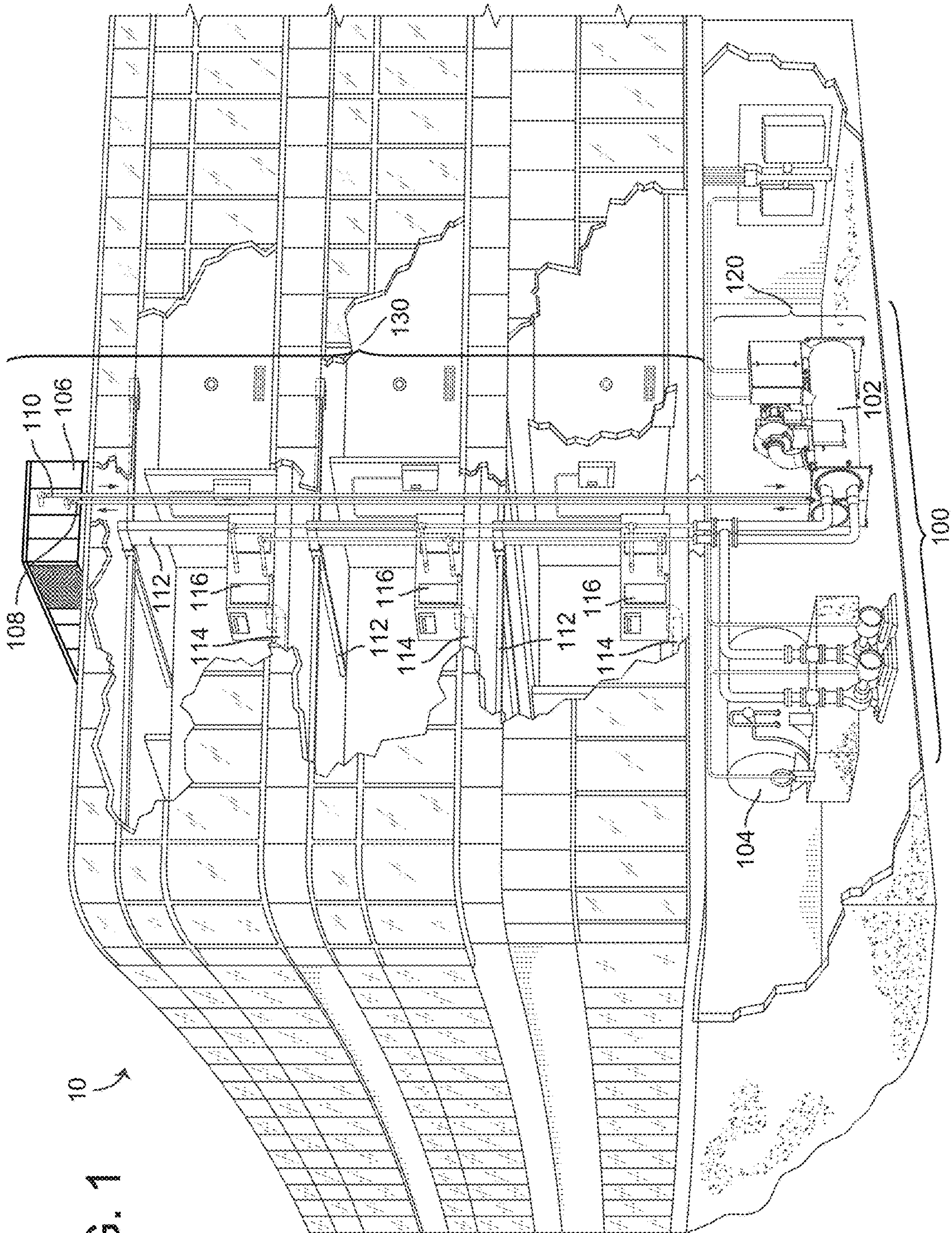
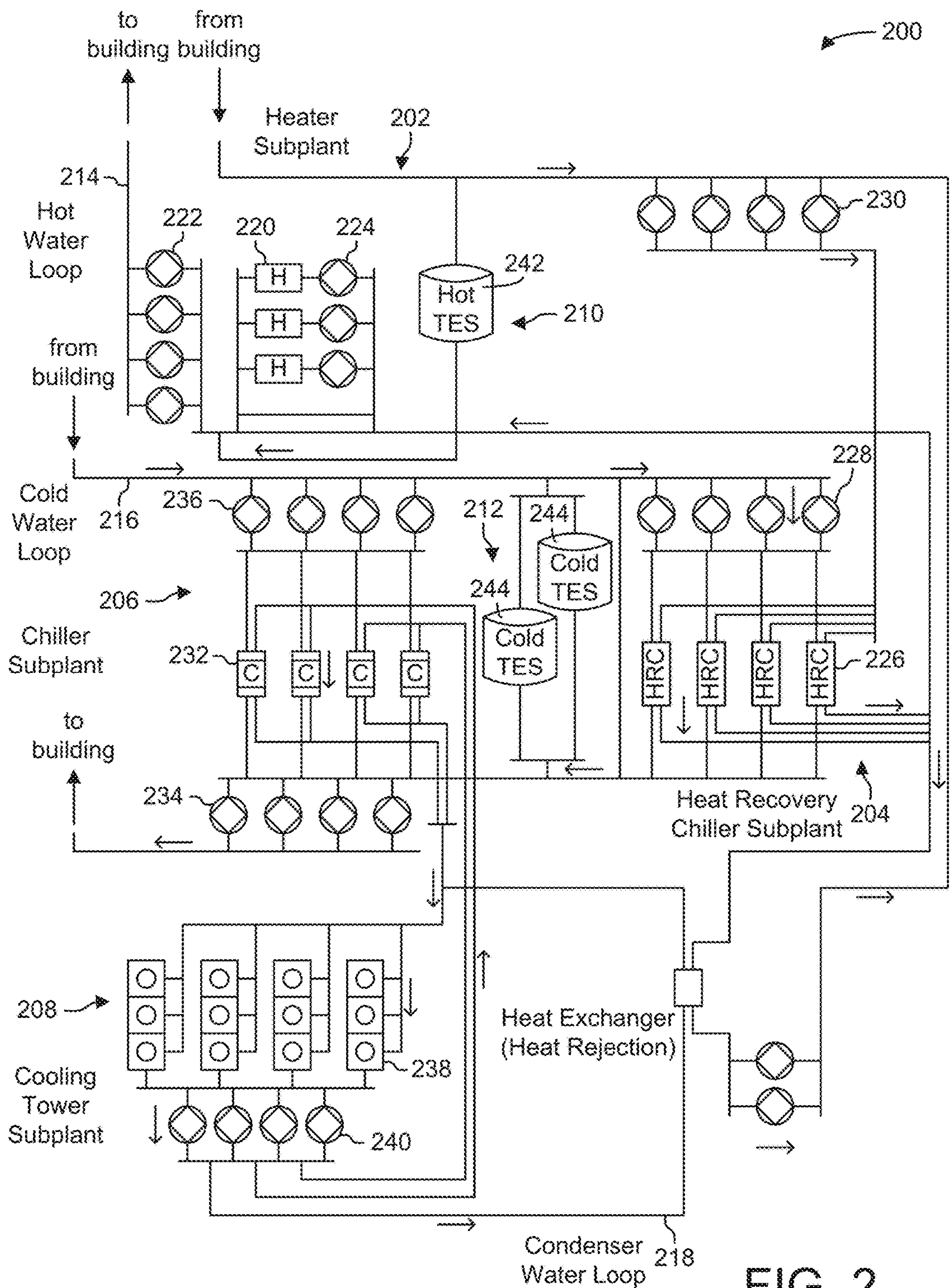


FIG. 1



200
to building
from building
Heater Subplant
202
214
Hot Water Loop
222
220
224
H
H
H
230
242
Hot TES
210
from building
228
Cold Water Loop
216
236
212
244
Cold TES
244
Cold TES
206
Chiller Subplant
232
C
C
C
C
HRC
HRC
HRC
HRC
226
to building
234
Heat Recovery Chiller Subplant
204
208
238
Cooling Tower Subplant
240
Heat Exchanger (Heat Rejection)
Condenser Water Loop
218

FIG. 2

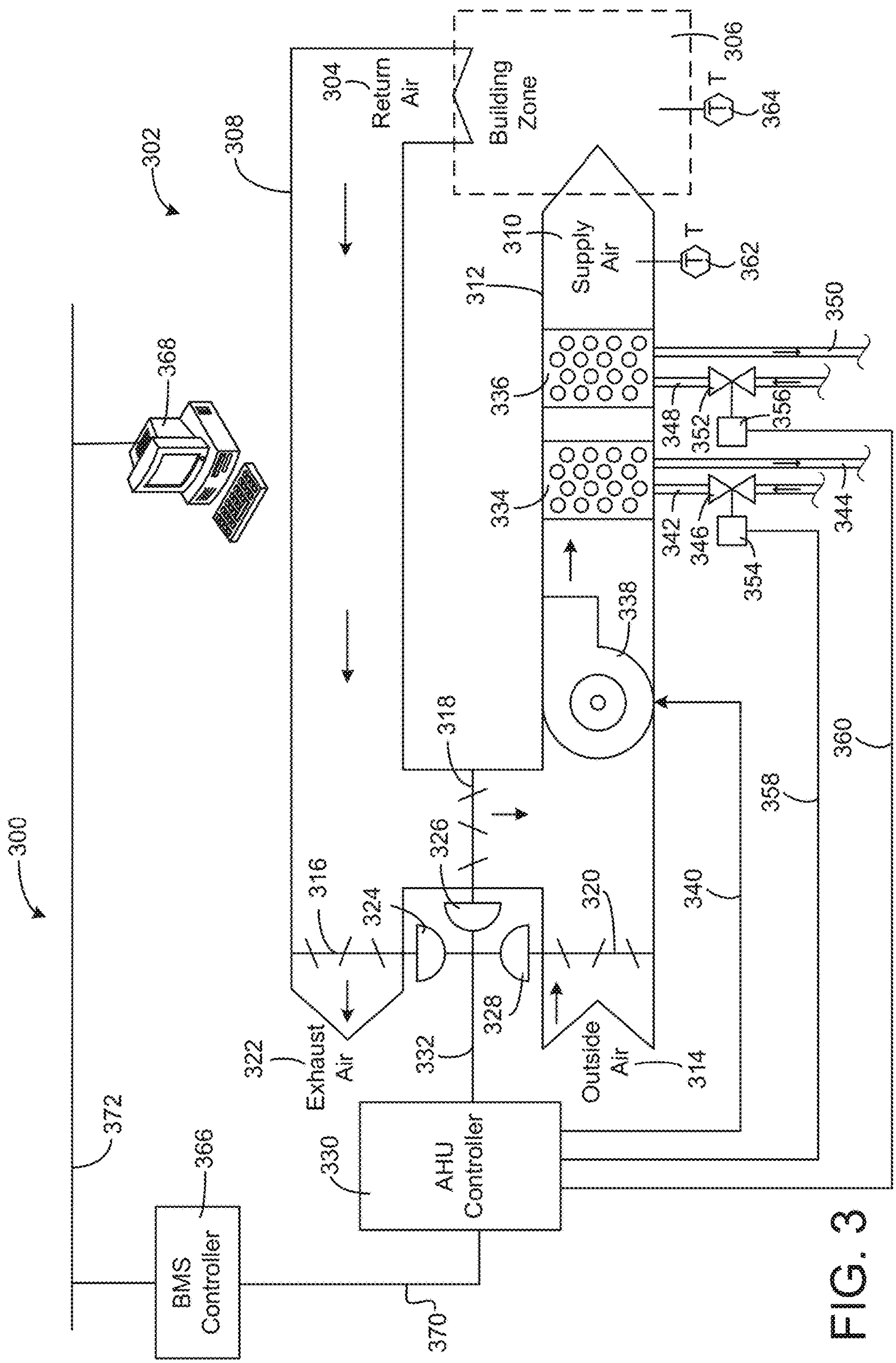

300
302
304
Return Air
306
Building Zone
308
310
Supply Air
312
314
Outside Air
316
318
320
322
Exhaust Air
324
326
328
330
AHU Controller
332
334
336
338
340
342
344
346
348
350
352
354
356
358
360
362
364
T
366
BMS Controller
368
370
372

FIG. 3

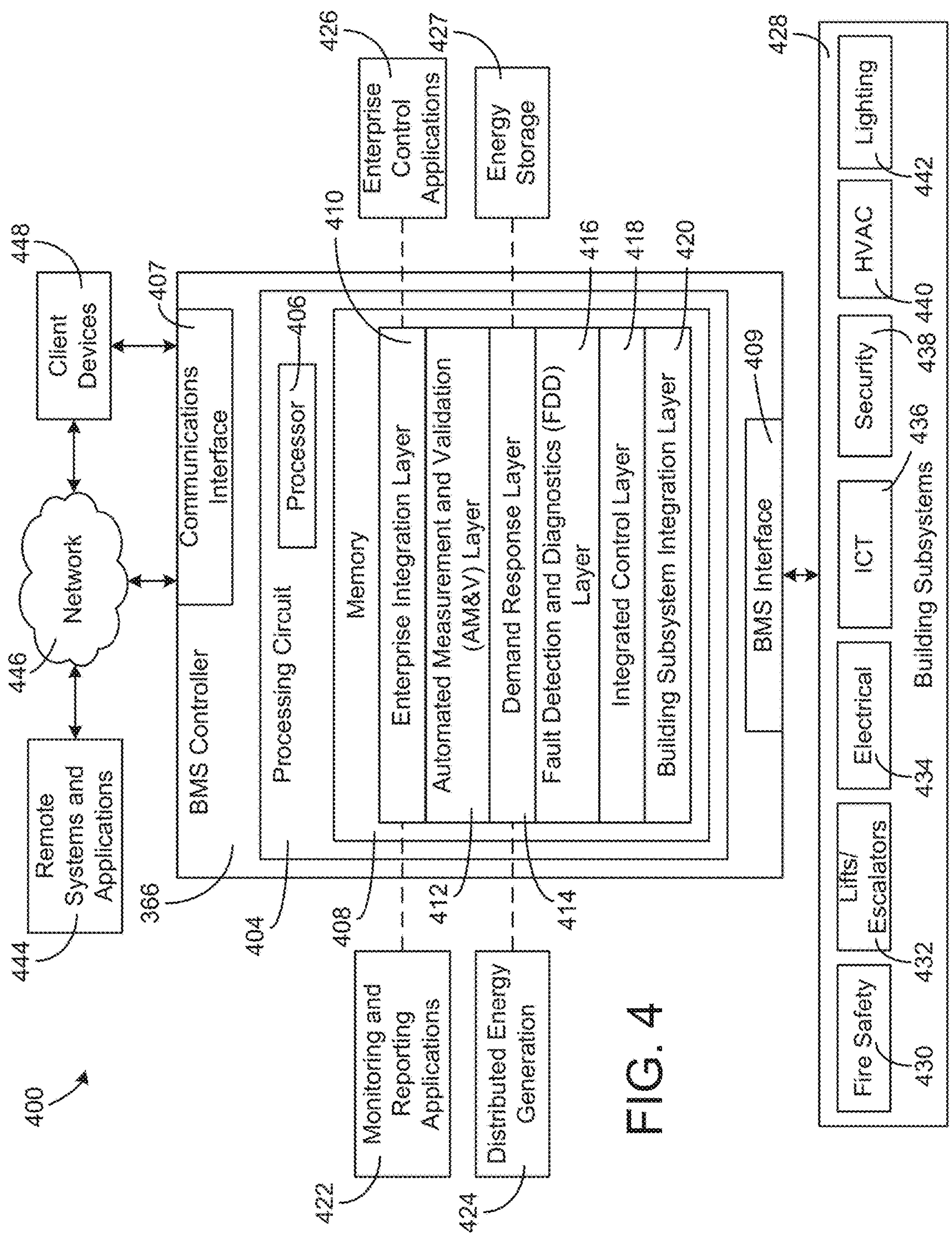

400
Remote Systems and Applications
444
446
Network
Client Devices
448
407
Communications Interface
BMS Controller
366
Processing Circuit
404
Processor
406
Memory
408
410
Enterprise Integration Layer
Automated Measurement and Validation (AM&V) Layer
412
Demand Response Layer
414
Fault Detection and Diagnostics (FDD) Layer
416
Integrated Control Layer
418
Building Subsystem Integration Layer
420
BMS Interface
409
Monitoring and Reporting Applications
422
Distributed Energy Generation
424
Enterprise Control Applications
426
Energy Storage
427
Building Subsystems
428
Fire Safety
430
Lifts/ Escalators
432
Electrical
434
ICT
436
Security
438
HVAC
440
Lighting
442

FIG. 4

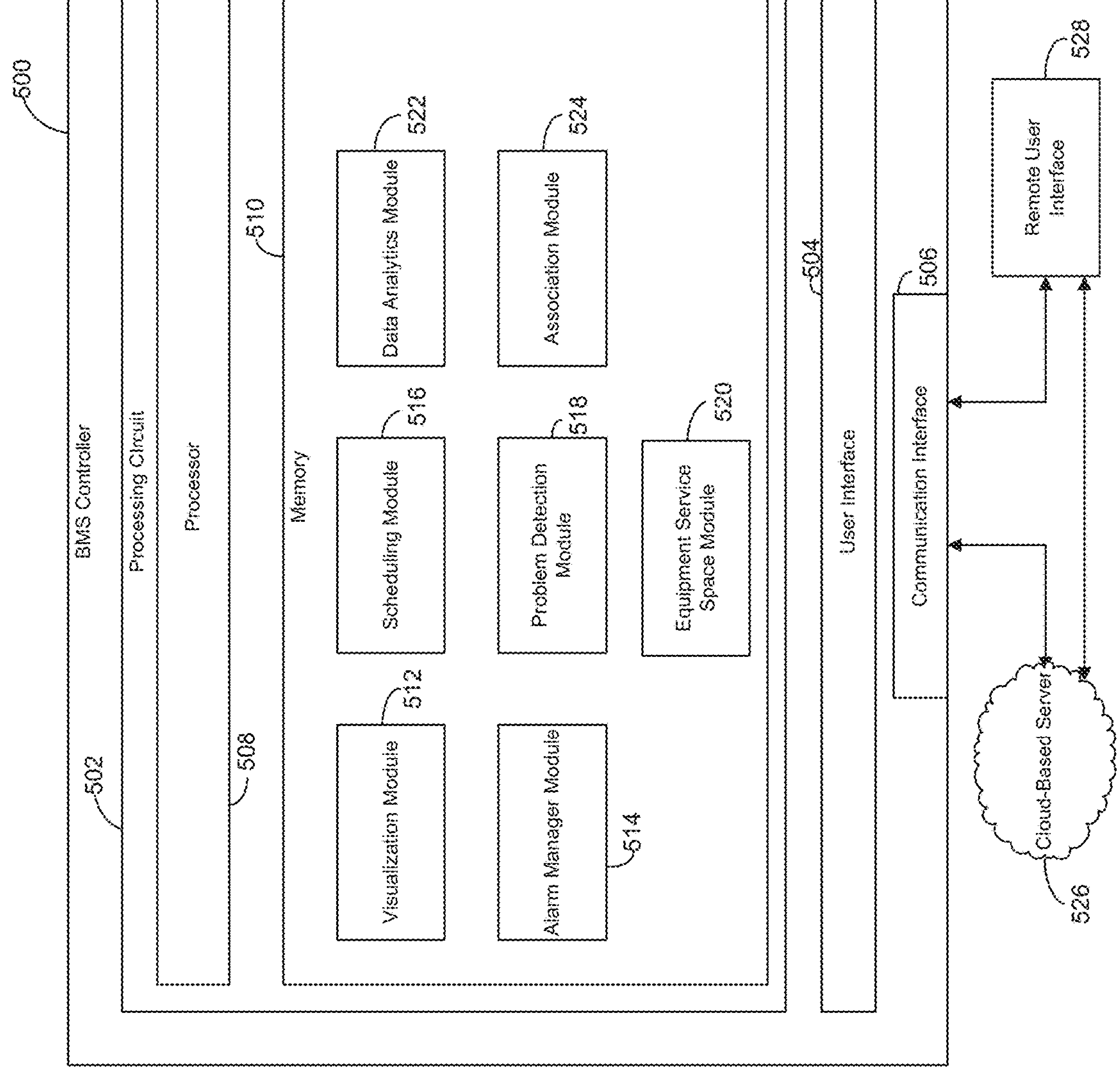

500
BMS Controller
502
Processing Circuit
508
Processor
510
Memory
Visualization Module
512
Alarm Manager Module
514
Scheduling Module
516
Problem Detection Module
518
Equipment Service Space Module
520
Data Analytics Module
522
Association Module
524
504
User Interface
506
Communication Interface
Remote User Interface
528
Cloud-Based Server
526

FIG. 5

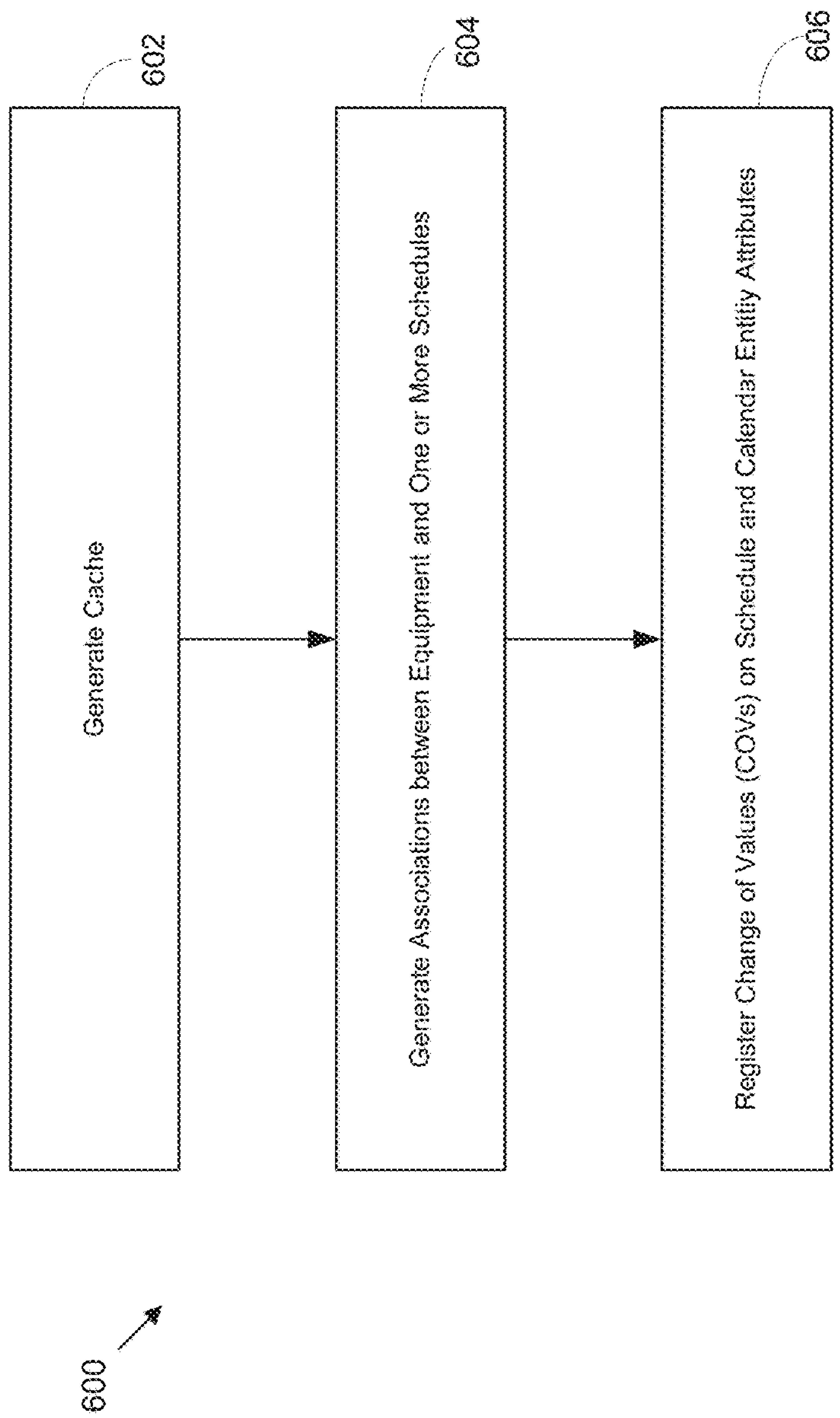

602
Generate Cache
604
Generate Associations between Equipment and One or More Schedules
606
Register Change of Values (COVs) on Schedule and Calendar Entity Attributes
600

FIG. 6

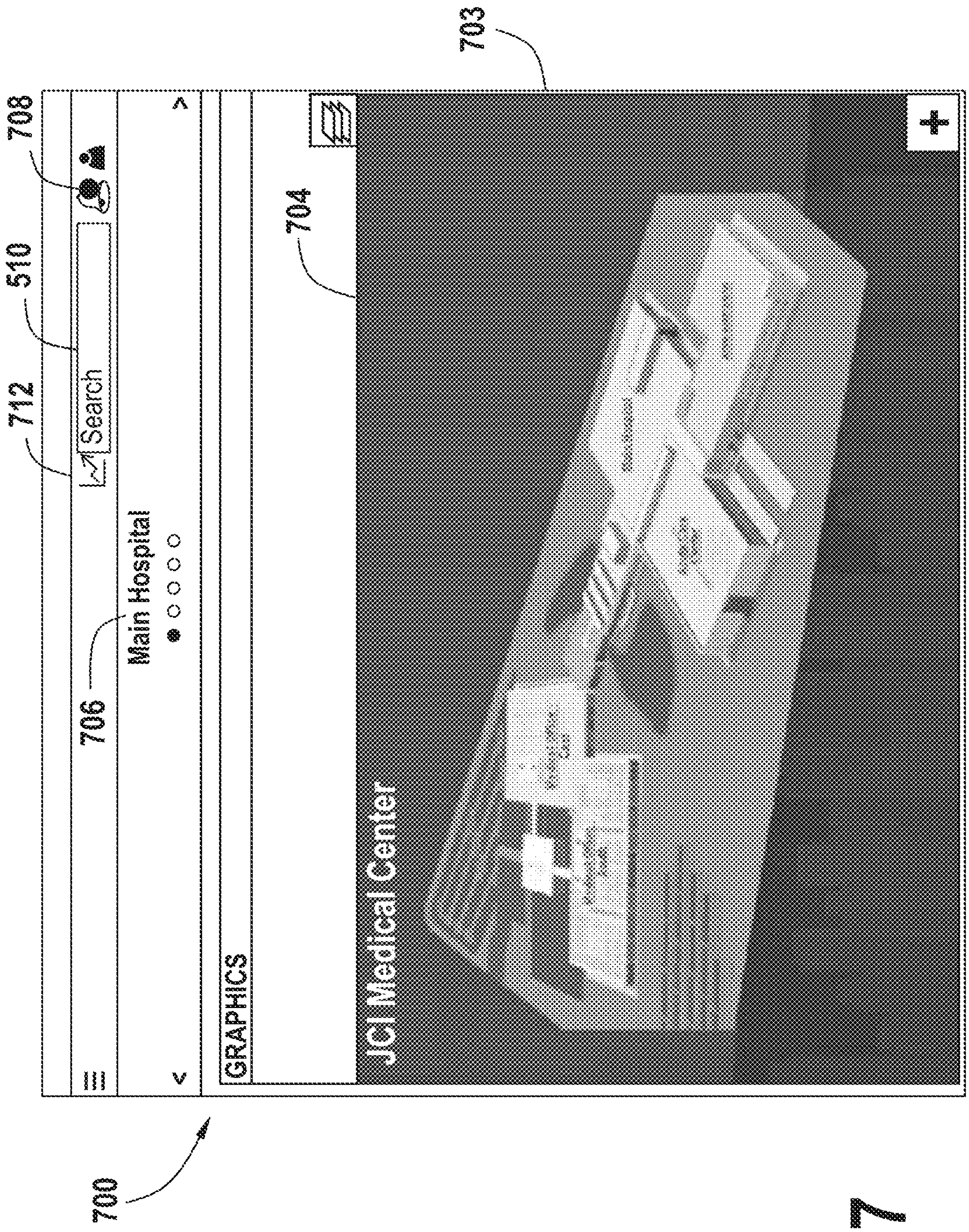

703
708
510
712
Search
706
Main Hospital
704
GRAPHICS
JCI Medical Center
700

FIG. 7

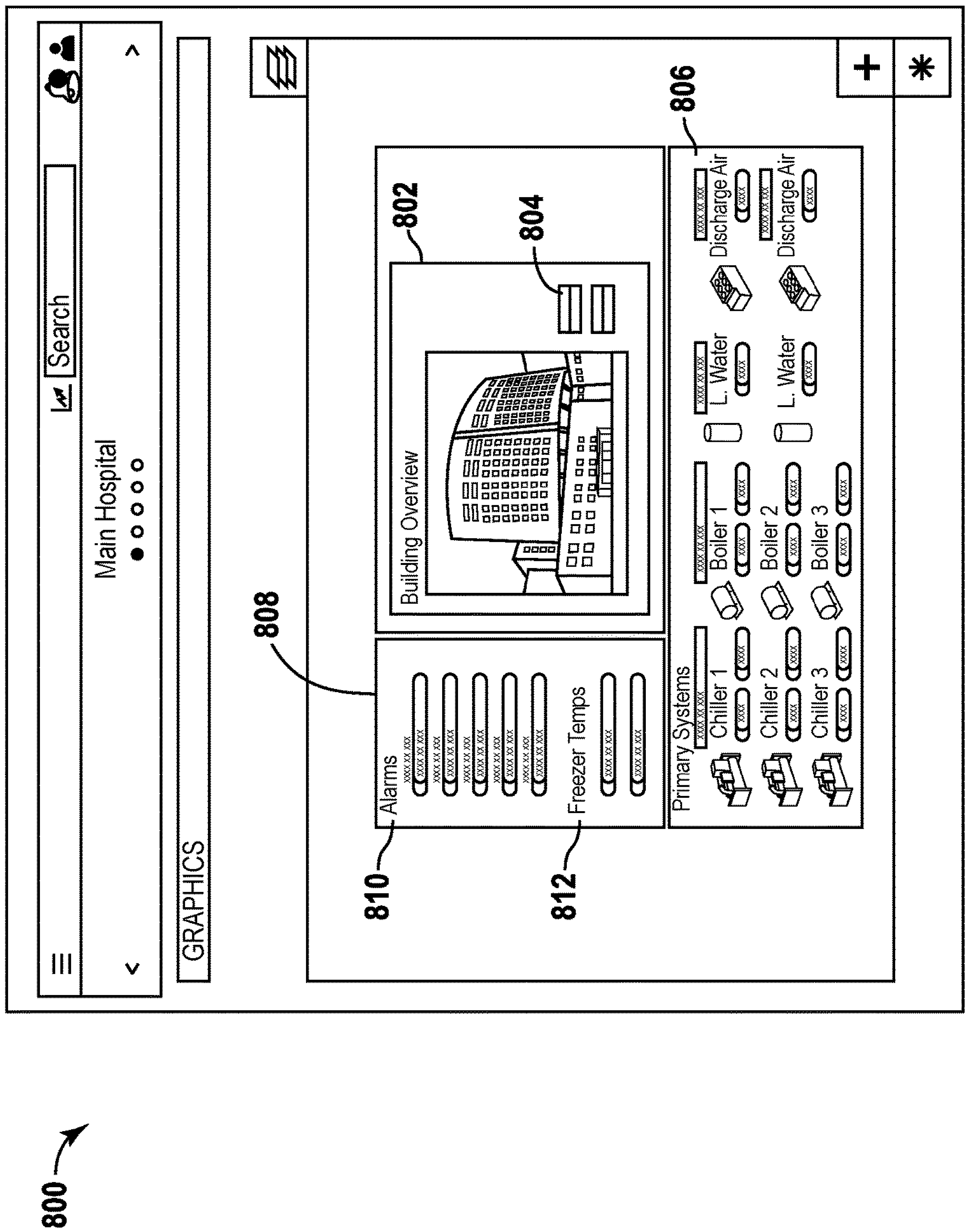

800
Main Hospital
Search
GRAPHICS
808
802
804
806
810
812
Building Overview
Alarms
Freezer Temps
Primary Systems
Chiller 1
Chiller 2
Chiller 3
Boiler 1
Boiler 2
Boiler 3
L. Water
L. Water
Discharge Air
Discharge Air

FIG. 8

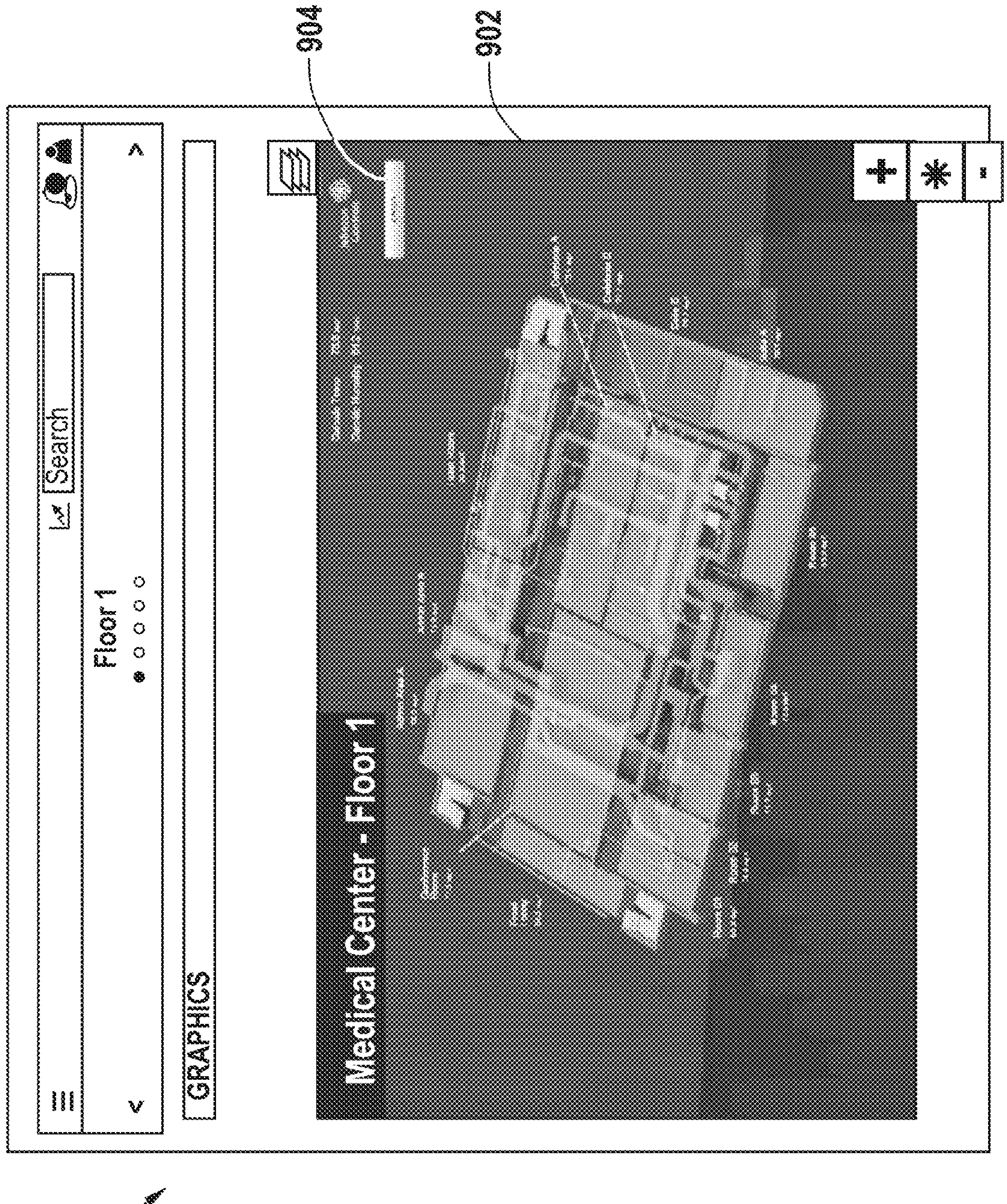


FIG. 9

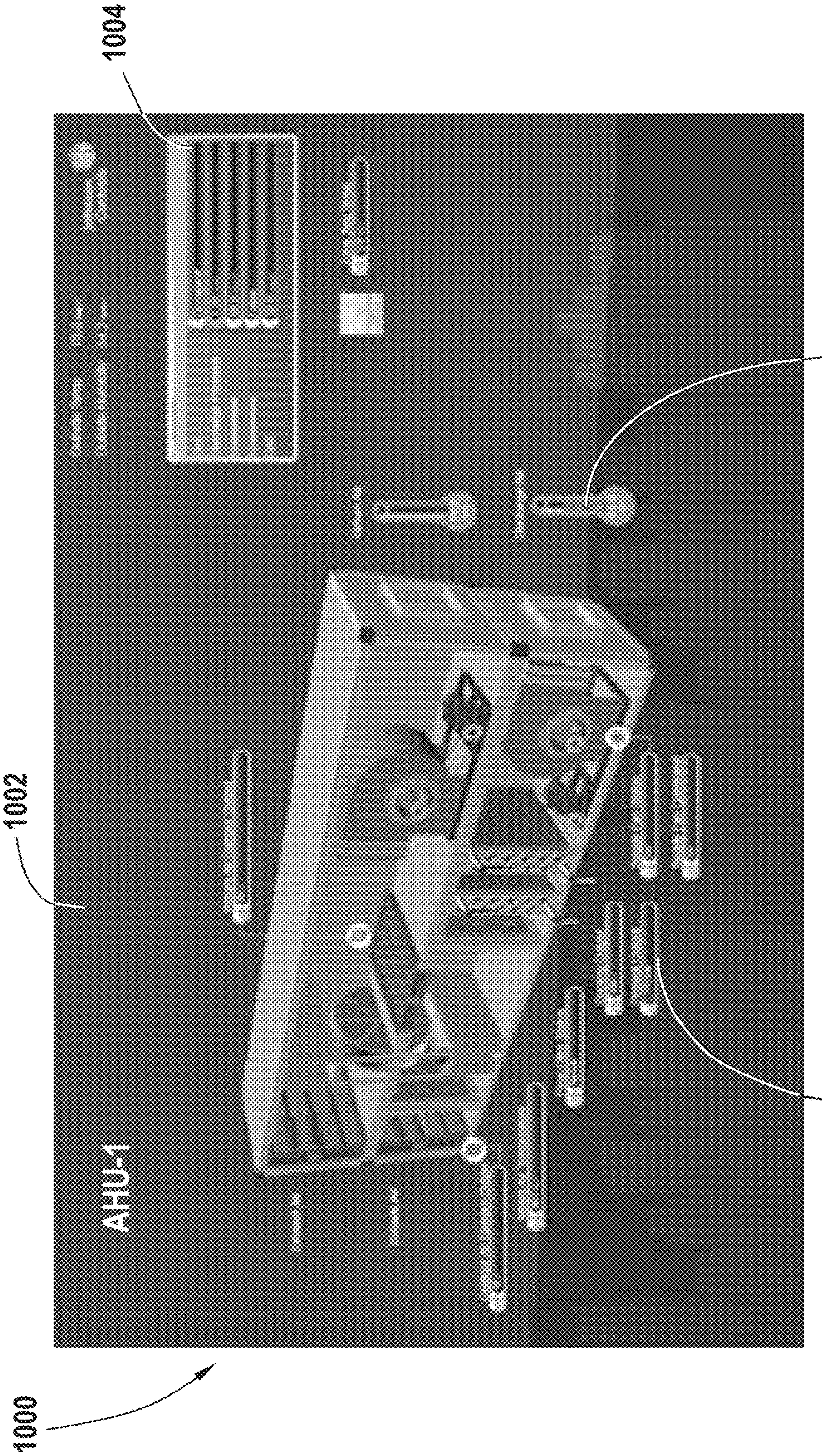


FIG. 10

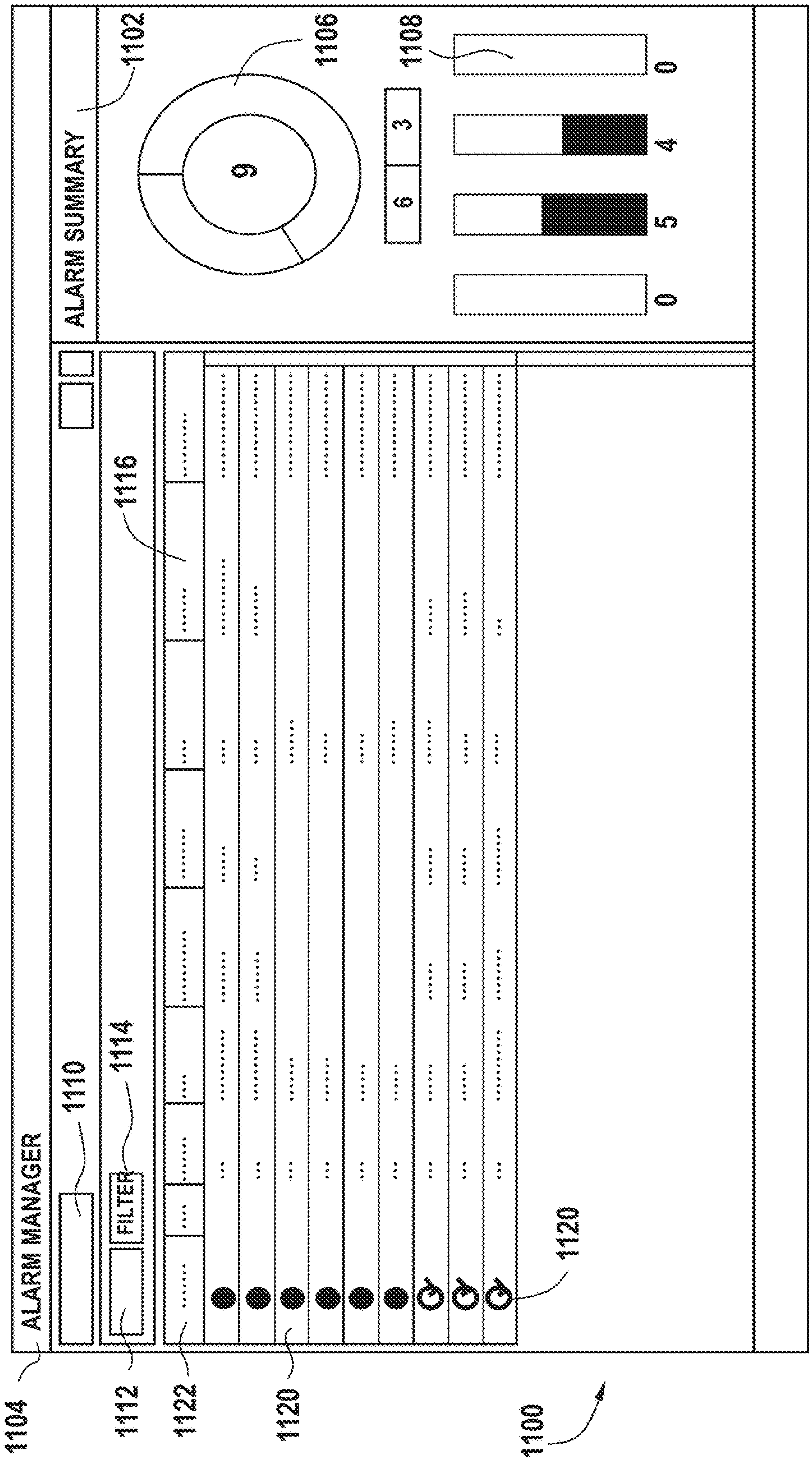

ALARM MANAGER
ALARM SUMMARY
FILTER
9
6
3
0
5
4
0
1100
1102
1104
1106
1108
1110
1112
1114
1116
1120
1120
1122

FIG. 11

1200

Priority	New	Type	Trigger Value	Equipment	Name	Space	Occurred
70	false	Alarm	Alarm	AHJ-2	FFILT-S	Floor 2	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-200	VAV-200	Room 12	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-203	VAV-203	Room 07	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-101	VAV-101	Conference Rm	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-103	VAV-103	Admin Area A	02/22/2016 1:27 PM
70	false	Unreliable	0.0 deg F	VAV-111	ZN-T	Room 3	02/22/2016 1:27 PM
70	false	Unreliable	0.0 deg F	VAV-107	ZN-T	Suite A	02/22/2016 1:27 PM
70	false	Unreliable	0.0 deg F	VAV-109	ZN-T	Room 01	02/22/2016 1:27 PM
70	false	Unreliable	0.0 deg F	VAV-105	ZN-T	Cafeteria A	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-102	VAV-102	Front Lobby	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-106	VAV-106	Cafeteria B	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-108	VAV-108	Suite B	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-201	VAV-201	Elevator Lobby	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-204	VAV-201	Room 08	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-207	VAV-207	Room 11	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-206	VAV-206	Room 10	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-111	VAV-111	Room 03	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-107	VAV-107	Suite A	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-109	VAV-109	Room 01	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-105	VAV-105	Cafeteria A	02/22/2016 1:27 PM
106	false	Normal	Online	AHJ-2	AHJ-2	Floor 2	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-205	VAV-205	Room 09	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-209	VAV-209	Room 13	02/22/2016 1:27 PM
106	false	Normal	Online	VAV-110	VAV-110	Room 02	02/22/2016 1:27 PM

FIG. 12

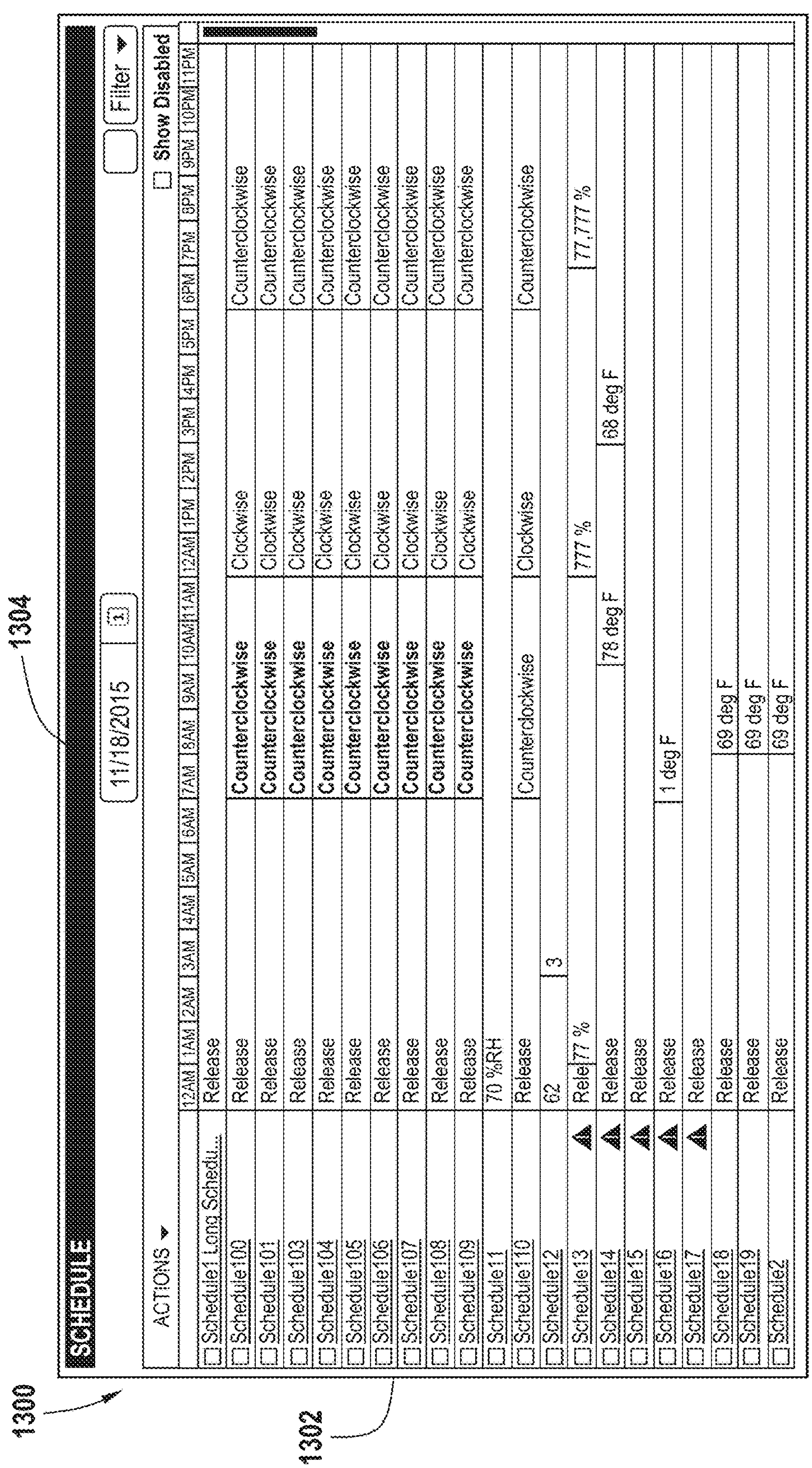

1300
1302
1304
SCHEDULE
ACTIONS
11/18/2015
Filter
Show Disabled
12AM 1AM 2AM 3AM 4AM 5AM 6AM 7AM 8AM 9AM 10AM 11AM 12AM 1PM 2PM 3PM 4PM 5PM 6PM 7PM 8PM 9PM 10PM 11PM
Schedule1 Long Schedu...
Schedule100
Schedule101
Schedule103
Schedule104
Schedule105
Schedule106
Schedule107
Schedule108
Schedule109
Schedule11
Schedule110
Schedule12
Schedule13
Schedule14
Schedule15
Schedule16
Schedule17
Schedule18
Schedule19
Schedule2
Release
Counterclockwise
Clockwise
70 %RH
62
3
77 %
777 %
77,777 %
78 deg F
68 deg F
1 deg F
69 deg F

FIG. 13

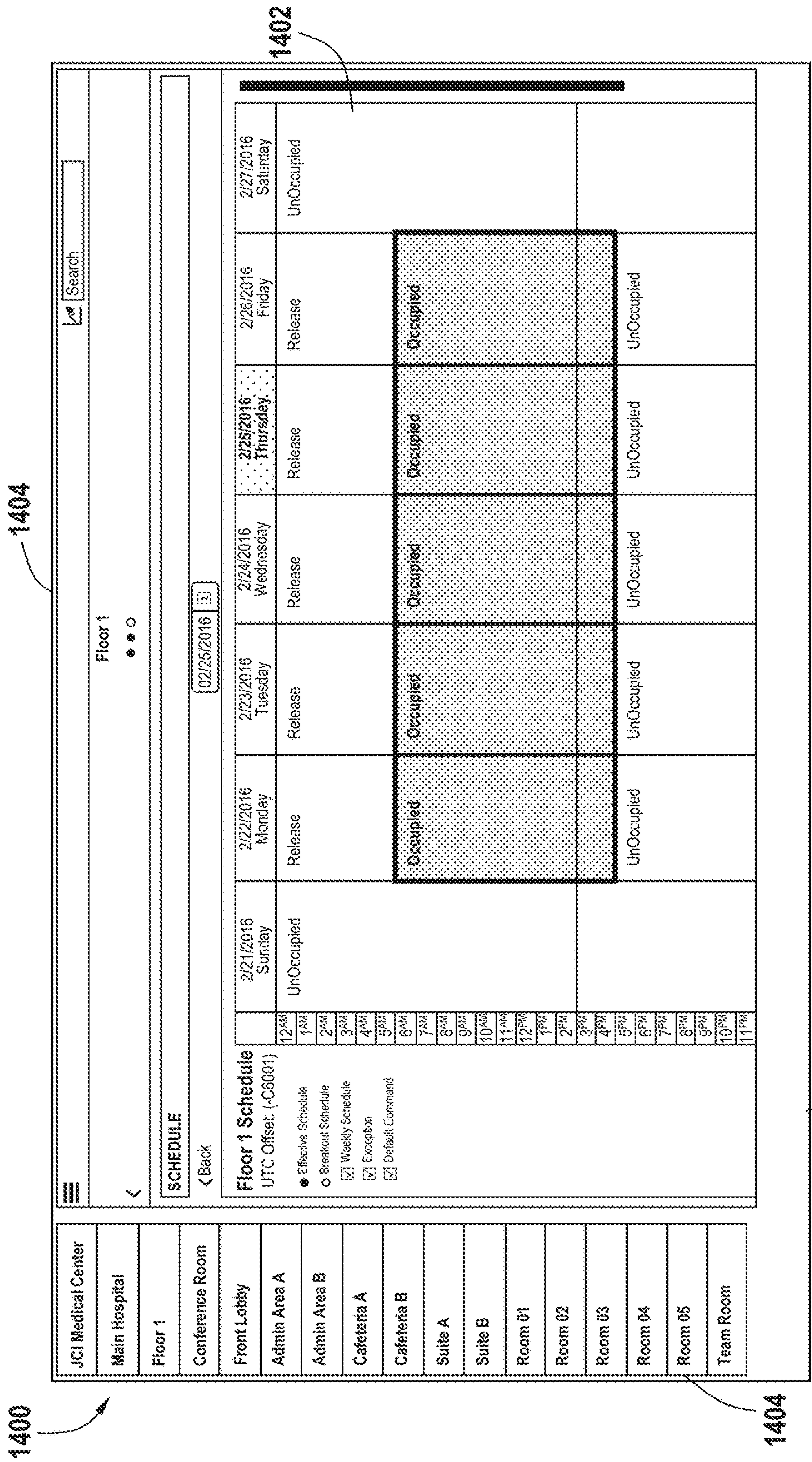
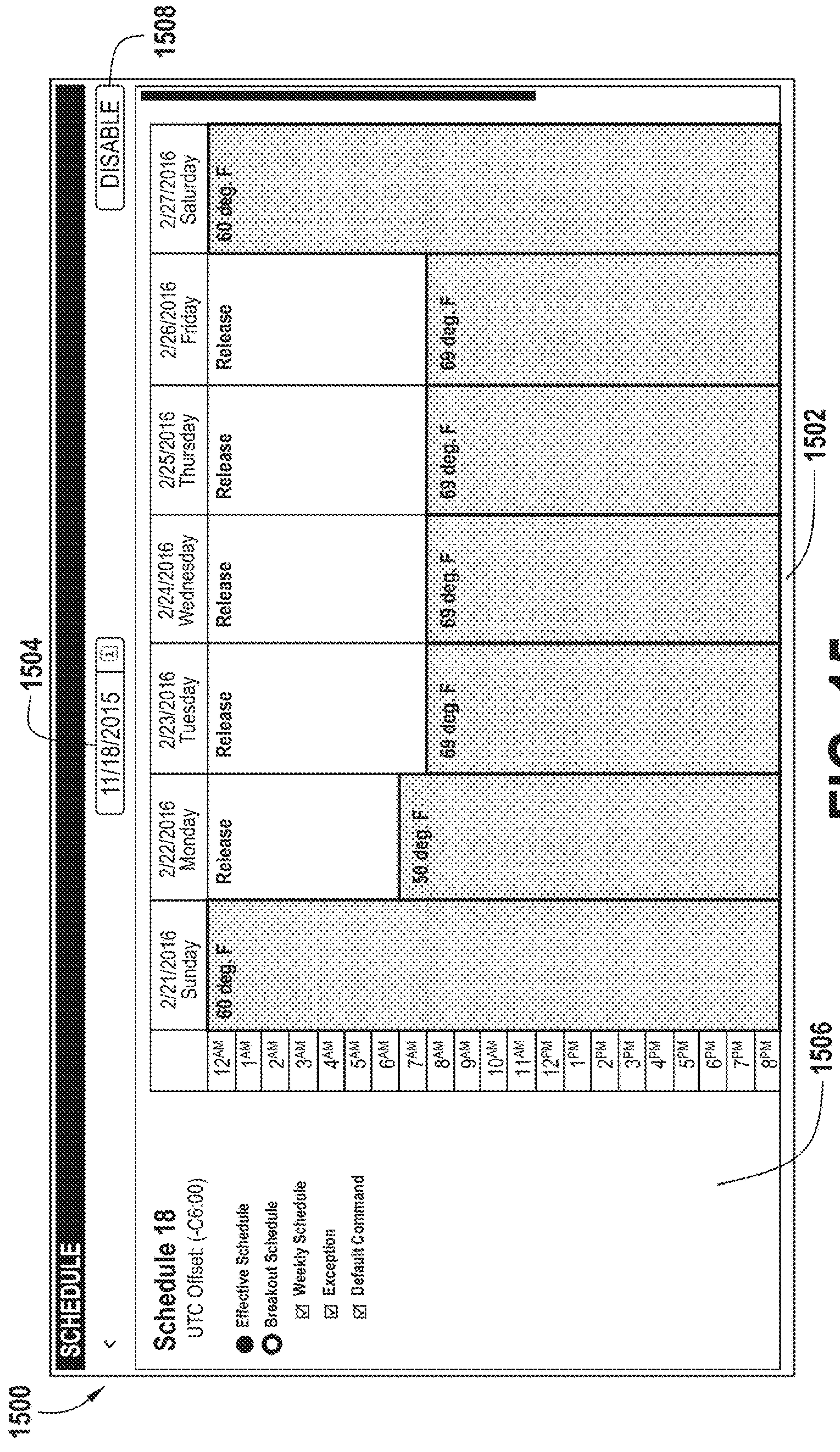

1400
1402
1404
1406
JCI Medical Center
Main Hospital
Floor 1
Conference Room
Front Lobby
Admin Area A
Admin Area B
Cafeteria A
Cafeteria B
Suite A
Suite B
Room 01
Room 02
Room 03
Room 04
Room 05
Team Room
Floor 1
Search
SCHEDULE
Back
02/25/2016
Floor 1 Schedule
UTC Offset: (-C6001)
Effective Schedule
Breakout Schedule
Weekly Schedule
Exception
Default Command
2/21/2016 Sunday
2/22/2016 Monday
2/23/2016 Tuesday
2/24/2016 Wednesday
2/25/2016 Thursday
2/26/2016 Friday
2/27/2016 Saturday
UnOccupied
Release
Occupied

FIG. 14



1500
1504
1508
1502
1506
SCHEDULE
11/18/2015
DISABLE
Schedule 18
UTC Offset: (-C6:00)
Effective Schedule
Breakout Schedule
Weekly Schedule
Exception
Default Command
2/21/2016 Sunday
2/22/2016 Monday
2/23/2016 Tuesday
2/24/2016 Wednesday
2/25/2016 Thursday
2/26/2016 Friday
2/27/2016 Saturday
60 deg. F
Release
50 deg. F
68 deg. F
69 deg. F
12AM
1AM
2AM
3AM
4AM
5AM
6AM
7AM
8AM
9AM
10AM
11AM
12PM
1PM
2PM
3PM
4PM
5PM
6PM
7PM
8PM

FIG. 15

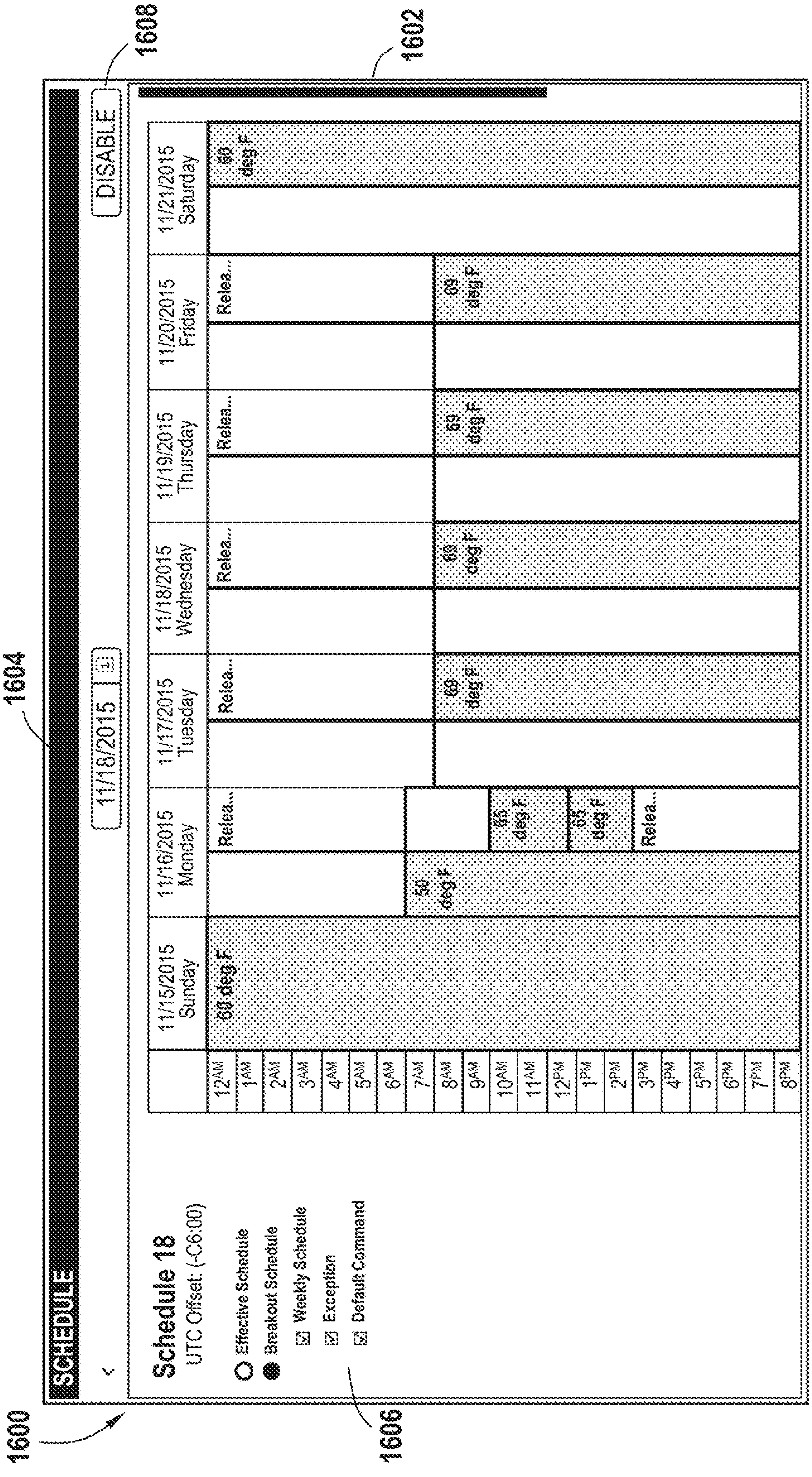

1600
1602
1604
1606
1608
SCHEDULE
DISABLE
11/18/2015
Schedule 18
UTC Offset: (-C6:00)
Effective Schedule
Breakout Schedule
Weekly Schedule
Exception
Default Command
11/15/2015 Sunday
11/16/2015 Monday
11/17/2015 Tuesday
11/18/2015 Wednesday
11/19/2015 Thursday
11/20/2015 Friday
11/21/2015 Saturday
12AM
1AM
2AM
3AM
4AM
5AM
6AM
7AM
8AM
9AM
10AM
11AM
12PM
1PM
2PM
3PM
4PM
5PM
6PM
7PM
8PM
60 deg F
50 deg F
65 deg F
69 deg F
Relea...

FIG. 16

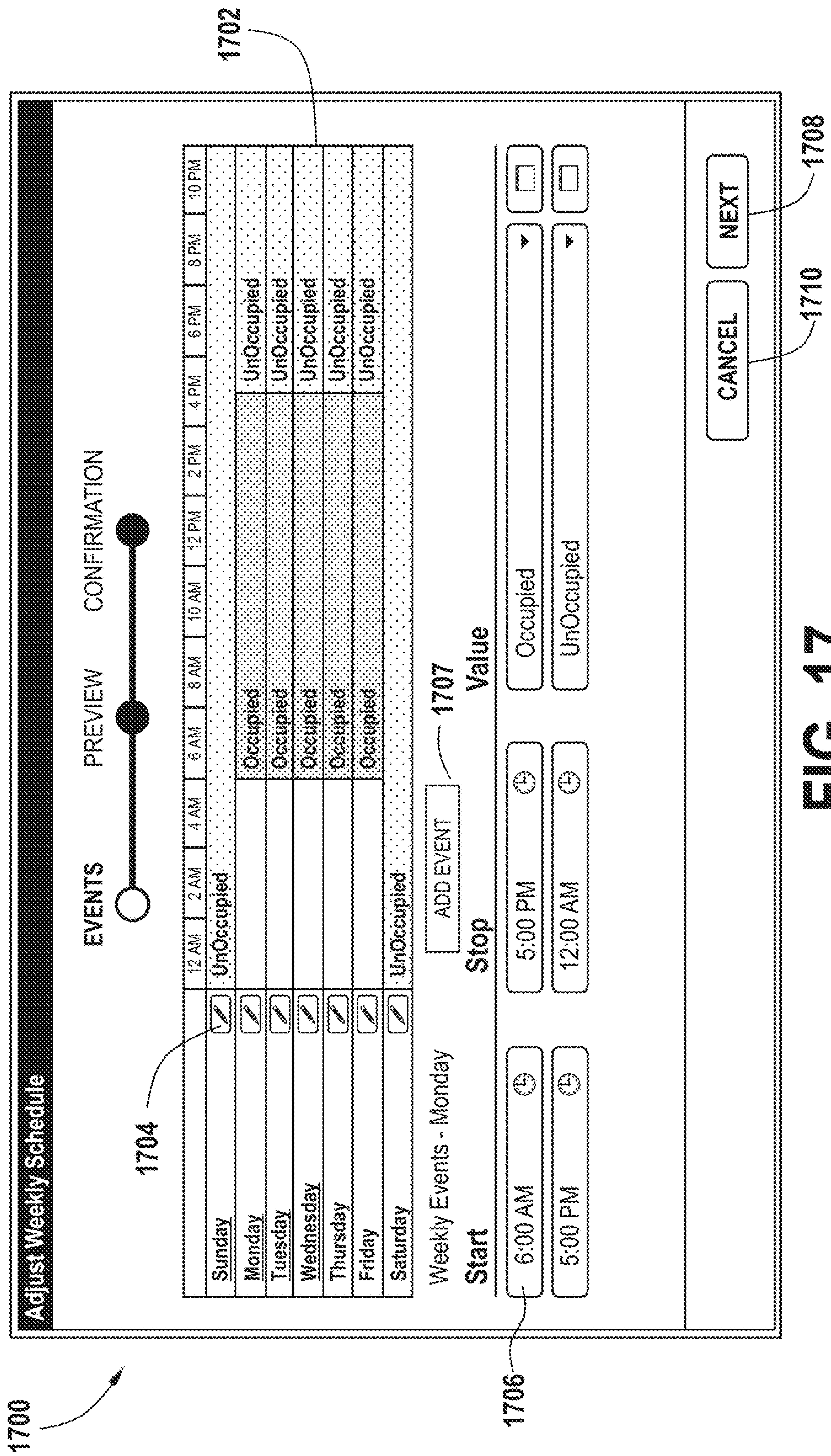

1700
1702
1704
1706
1707
1708
1710
Adjust Weekly Schedule
EVENTS
PREVIEW
CONFIRMATION
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
UnOccupied
Occupied
ADD EVENT
Weekly Events - Monday
Start
Stop
Value
6:00 AM
5:00 PM
Occupied
5:00 PM
12:00 AM
UnOccupied
CANCEL
NEXT

FIG. 17

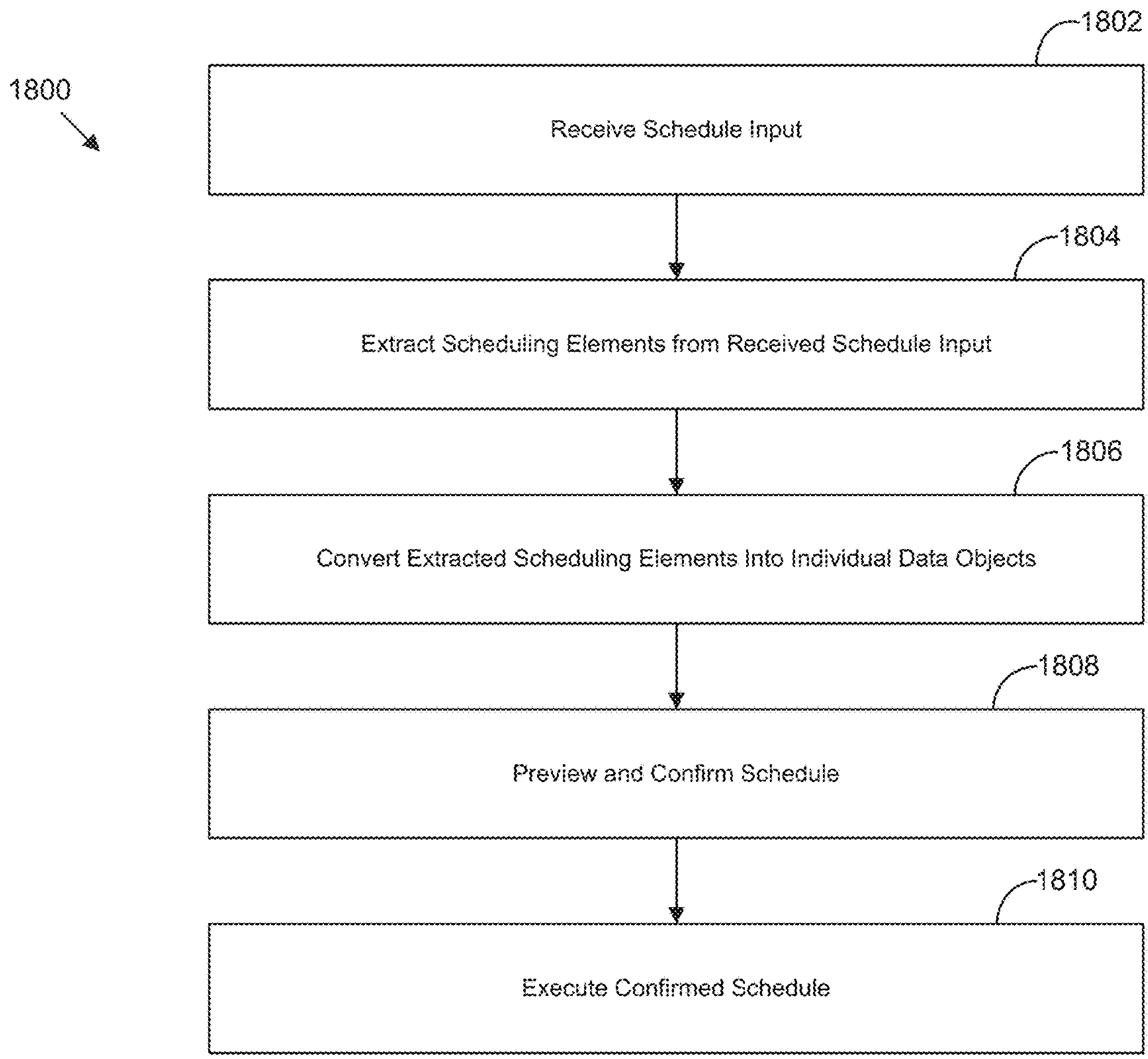

1800
1802
Receive Schedule Input
1804
Extract Scheduling Elements from Received Schedule Input
1806
Convert Extracted Scheduling Elements Into Individual Data Objects
1808
Preview and Confirm Schedule
1810
Execute Confirmed Schedule

FIG. 18

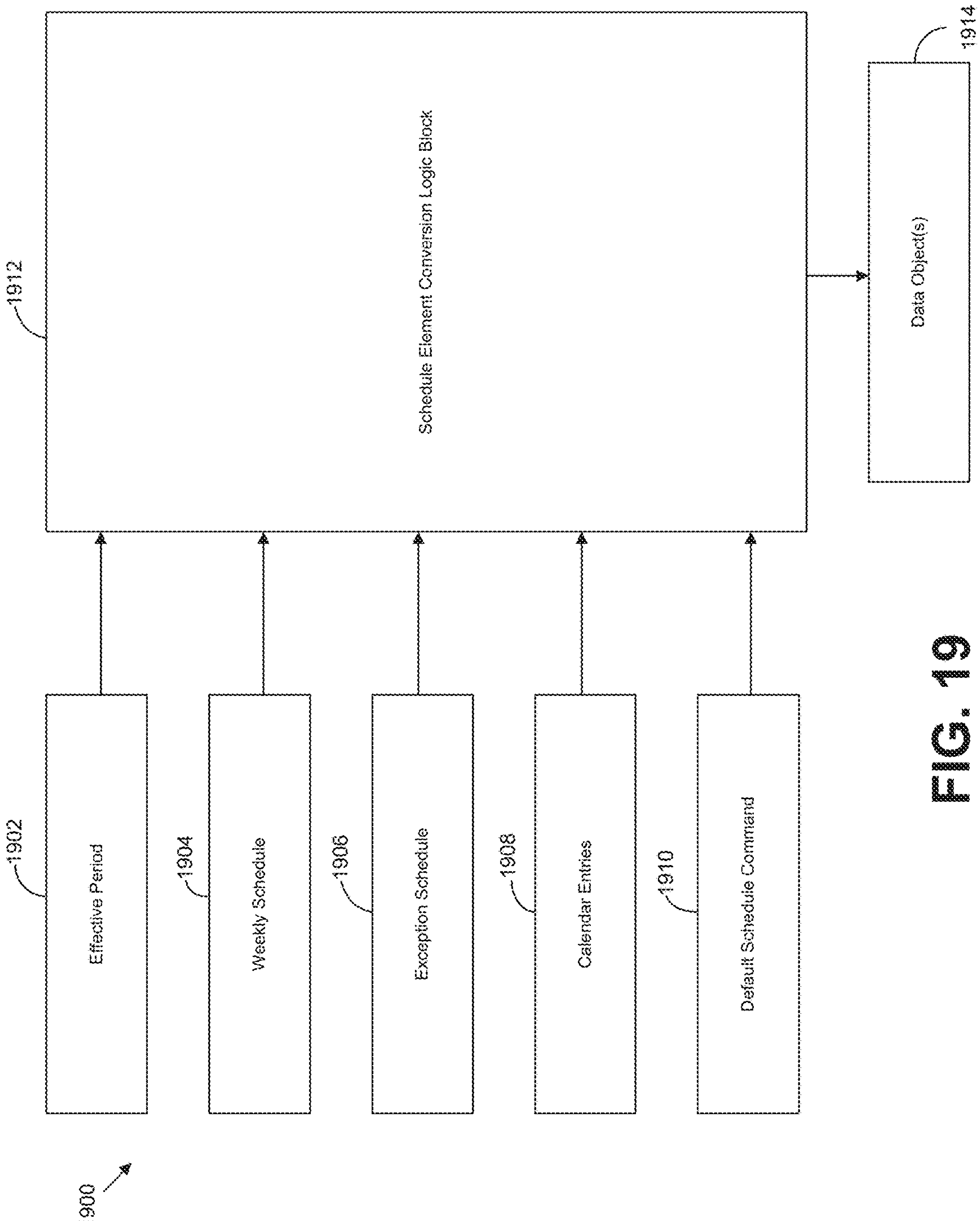

1900
1902
Effective Period
1904
Weekly Schedule
1906
Exception Schedule
1908
Calendar Entries
1910
Default Schedule Command
1912
Schedule Element Conversion Logic Block
1914
Data Object(s)

FIG. 19

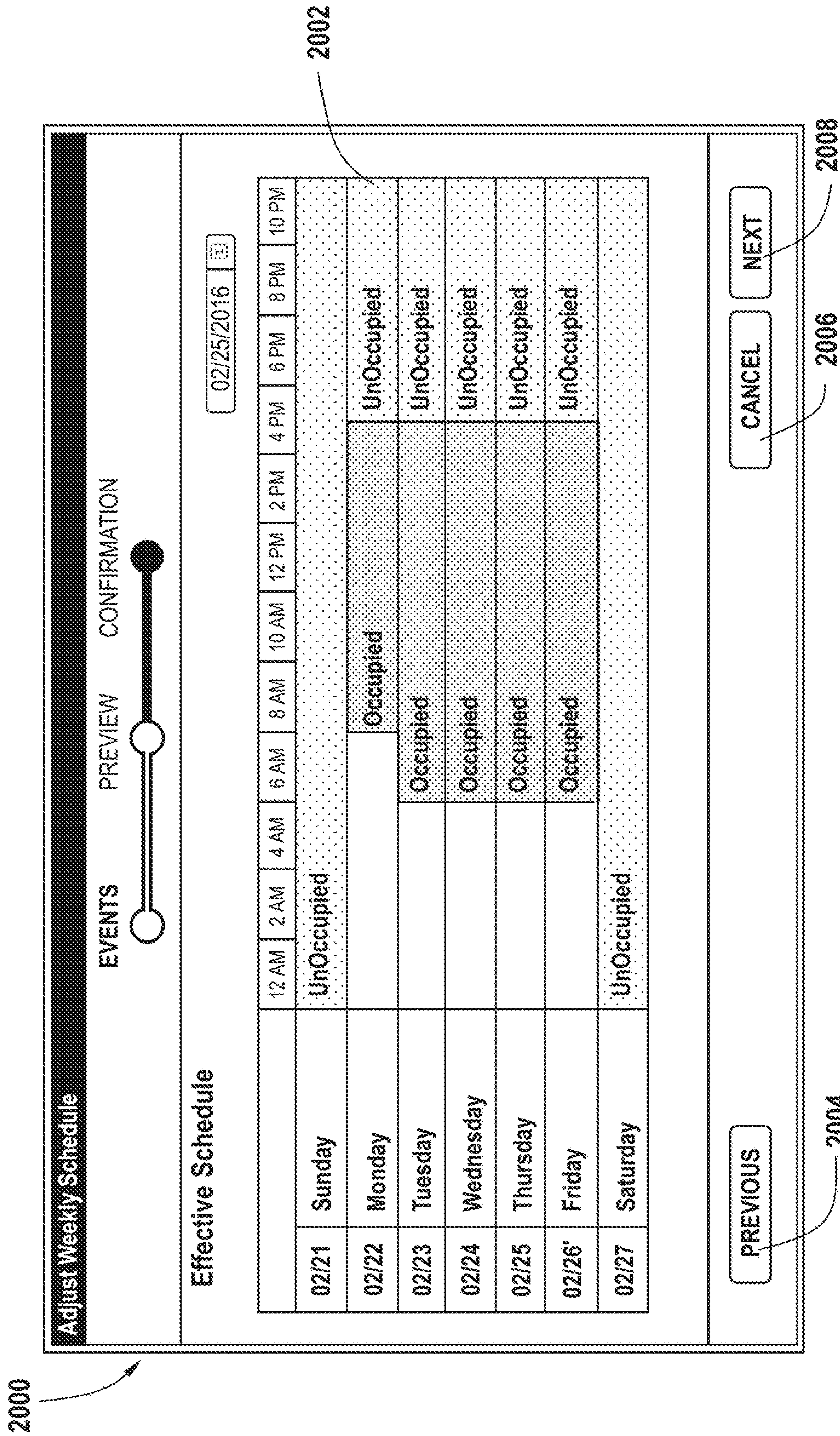

2000
2002
Adjust Weekly Schedule
EVENTS
PREVIEW
CONFIRMATION
Effective Schedule
02/25/2016
12 AM
2 AM
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
02/21 Sunday
02/22 Monday
02/23 Tuesday
02/24 Wednesday
02/25 Thursday
02/26 Friday
02/27 Saturday
UnOccupied
Occupied
PREVIOUS
CANCEL
NEXT
2004
2006
2008

FIG. 20

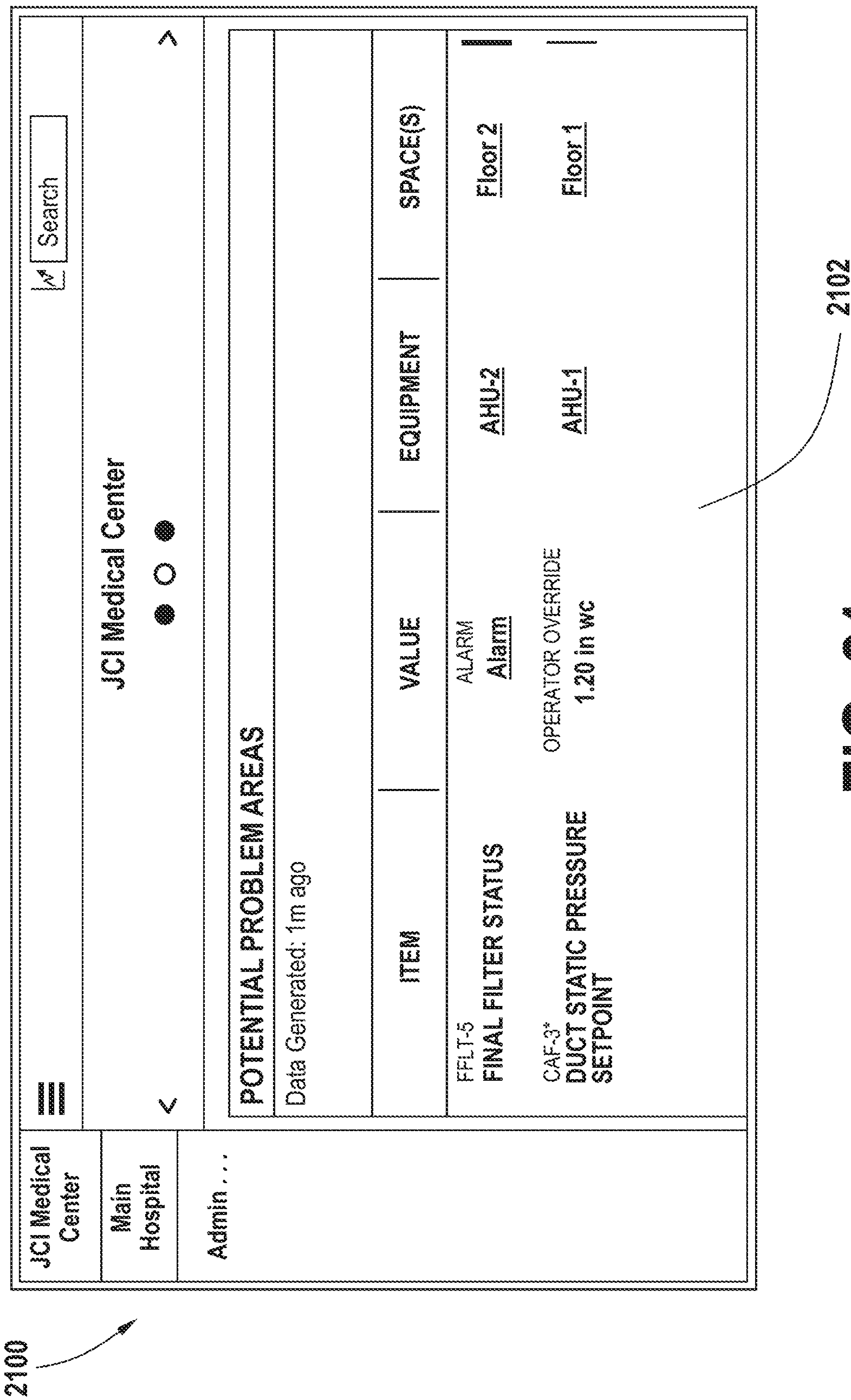

JCI Medical Center
Main Hospital
Admin . . .
Search
JCI Medical Center
POTENTIAL PROBLEM AREAS
Data Generated: 1m ago
ITEM
VALUE
EQUIPMENT
SPACE(S)
FFLT-5
FINAL FILTER STATUS
ALARM
Alarm
AHU-2
Floor 2
CAF-3*
DUCT STATIC PRESSURE SETPOINT
OPERATOR OVERRIDE
1.20 in wc
AHU-1
Floor 1
2100
2102

FIG. 21

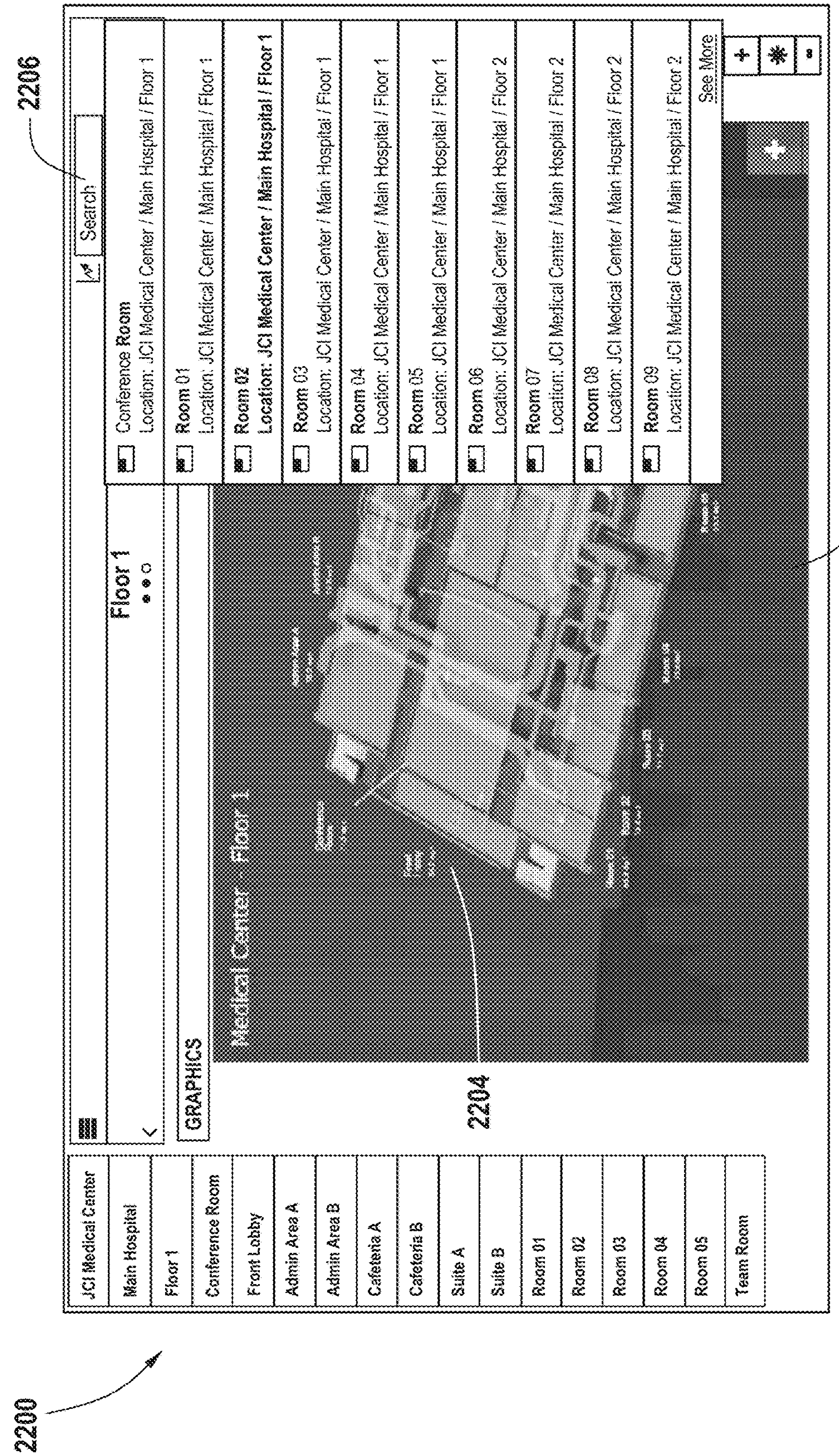

2200
2206
2202
2204
JCI Medical Center
Main Hospital
Floor 1
Conference Room
Front Lobby
Admin Area A
Admin Area B
Cafeteria A
Cafeteria B
Suite A
Suite B
Room 01
Room 02
Room 03
Room 04
Room 05
Team Room
Floor 1
GRAPHICS
Medical Center - Floor 1
Search
Conference Room
Location: JCI Medical Center / Main Hospital / Floor 1
Room 01
Location: JCI Medical Center / Main Hospital / Floor 1
Room 02
Location: JCI Medical Center / Main Hospital / Floor 1
Room 03
Location: JCI Medical Center / Main Hospital / Floor 1
Room 04
Location: JCI Medical Center / Main Hospital / Floor 1
Room 05
Location: JCI Medical Center / Main Hospital / Floor 1
Room 06
Location: JCI Medical Center / Main Hospital / Floor 2
Room 07
Location: JCI Medical Center / Main Hospital / Floor 2
Room 08
Location: JCI Medical Center / Main Hospital / Floor 2
Room 09
Location: JCI Medical Center / Main Hospital / Floor 2
See More

FIG. 22

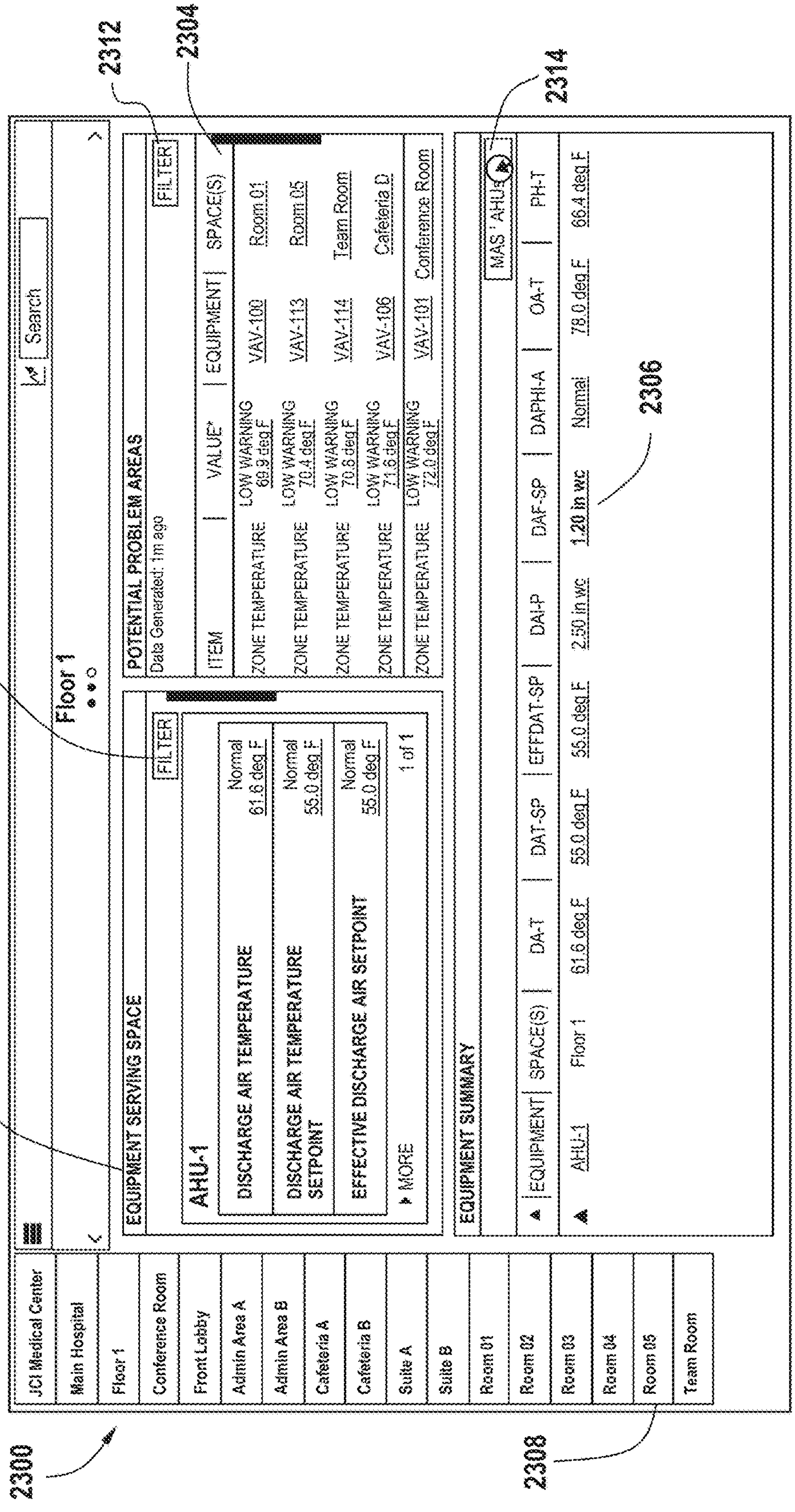
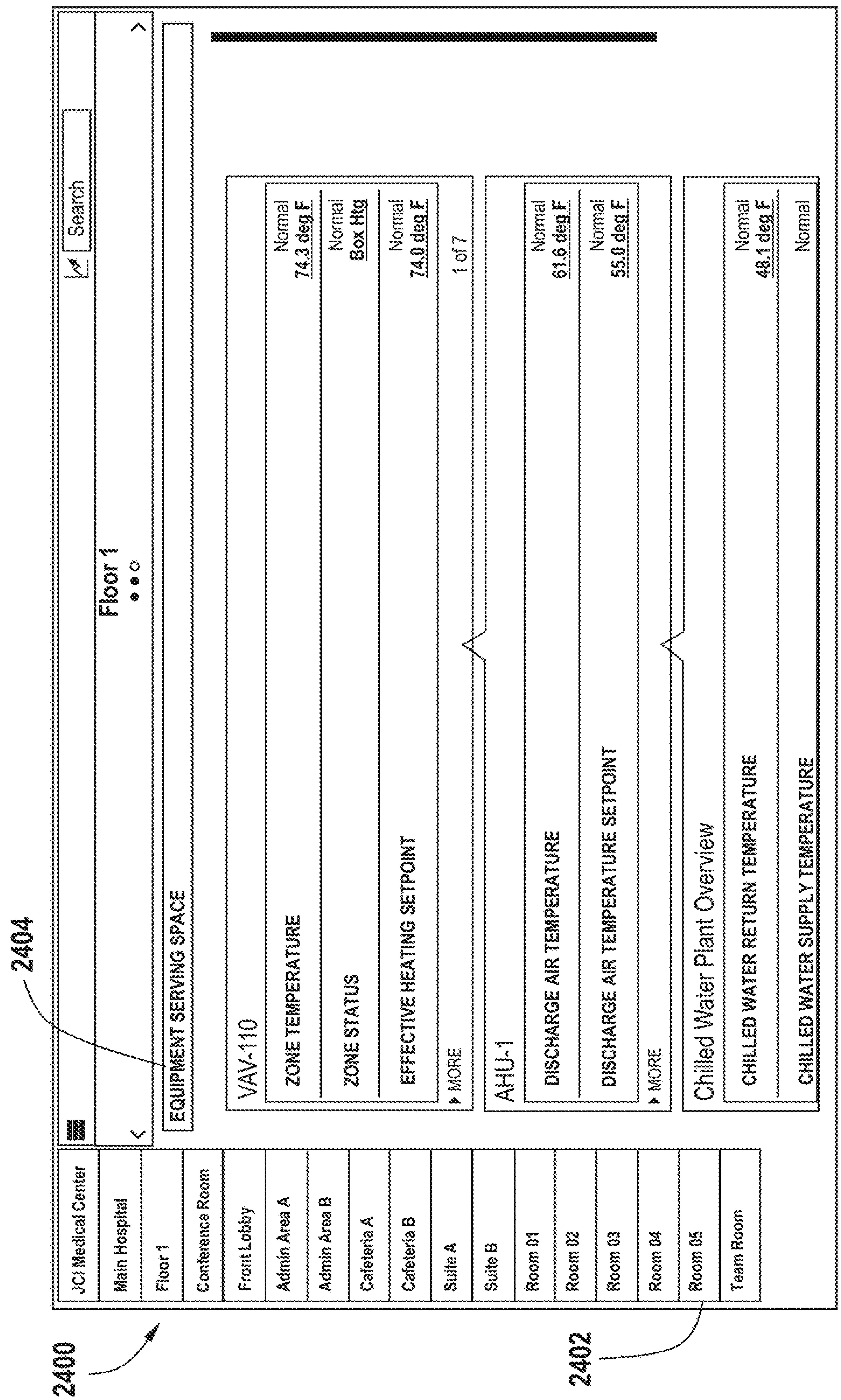

2300
2302
2304
2306
2308
2310
2312
2314
JCI Medical Center
Main Hospital
Floor 1
Conference Room
Front Lobby
Admin Area A
Admin Area B
Cafeteria A
Cafeteria B
Suite A
Suite B
Room 01
Room 02
Room 03
Room 04
Room 05
Team Room
Search
Floor 1
EQUIPMENT SERVING SPACE
FILTER
AHU-1
DISCHARGE AIR TEMPERATURE
Normal 61.6 deg F
DISCHARGE AIR TEMPERATURE SETPOINT
Normal 55.0 deg F
EFFECTIVE DISCHARGE AIR SETPOINT
Normal 55.0 deg F
MORE
1 of 1
POTENTIAL PROBLEM AREAS
Data Generated: 1m ago
FILTER
ITEM
VALUE*
EQUIPMENT
SPACE(S)
ZONE TEMPERATURE
LOW WARNING 69.9 deg F
VAV-100
Room 01
ZONE TEMPERATURE
LOW WARNING 70.4 deg F
VAV-113
Room 05
ZONE TEMPERATURE
LOW WARNING 70.8 deg F
VAV-114
Team Room
ZONE TEMPERATURE
LOW WARNING 71.6 deg F
VAV-106
Cafeteria D
ZONE TEMPERATURE
LOW WARNING 72.0 deg F
VAV-101
Conference Room
EQUIPMENT SUMMARY
MAS' AHUs
EQUIPMENT
SPACE(S)
DA-T
DAT-SP
EFFDAT-SP
DAI-P
DAF-SP
DAPHI-A
OA-T
PH-T
AHU-1
Floor 1
61.6 deg F
55.0 deg F
55.0 deg F
2.50 in wc
1.20 in wc
Normal
78.0 deg F
66.4 deg F

FIG. 23



2400
2402
2404
JCI Medical Center
Main Hospital
Floor 1
Conference Room
Front Lobby
Admin Area A
Admin Area B
Cafeteria A
Cafeteria B
Suite A
Suite B
Room 01
Room 02
Room 03
Room 04
Room 05
Team Room
Search
Floor 1
EQUIPMENT SERVING SPACE
VAV-110
ZONE TEMPERATURE
Normal
74.3 deg F
ZONE STATUS
Normal
Box Htg
EFFECTIVE HEATING SETPOINT
Normal
74.0 deg F
MORE
1 of 7
AHU-1
DISCHARGE AIR TEMPERATURE
Normal
61.6 deg F
DISCHARGE AIR TEMPERATURE SETPOINT
Normal
55.0 deg F
MORE
Chilled Water Plant Overview
CHILLED WATER RETURN TEMPERATURE
Normal
48.1 deg F
CHILLED WATER SUPPLY TEMPERATURE
Normal

FIG. 24

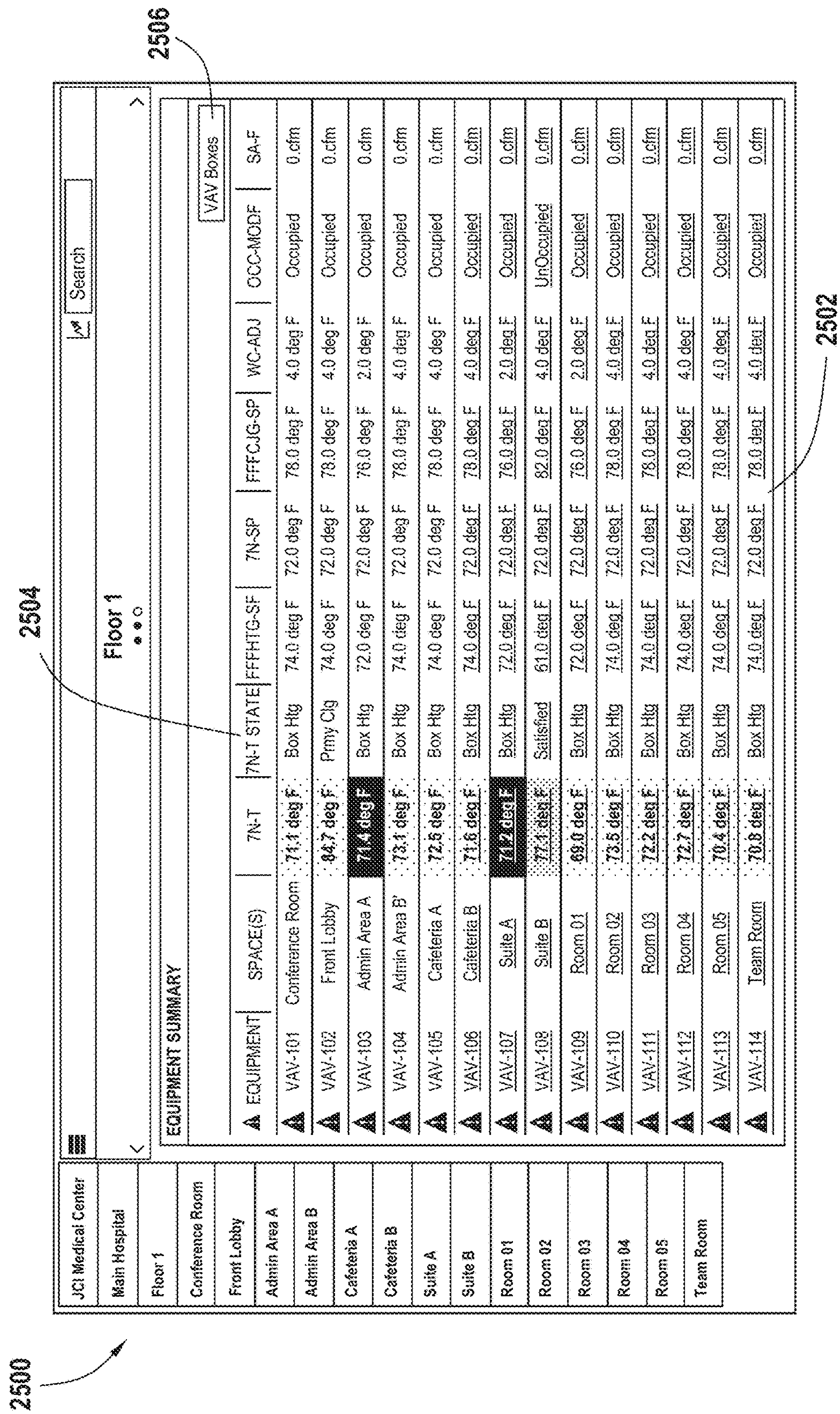
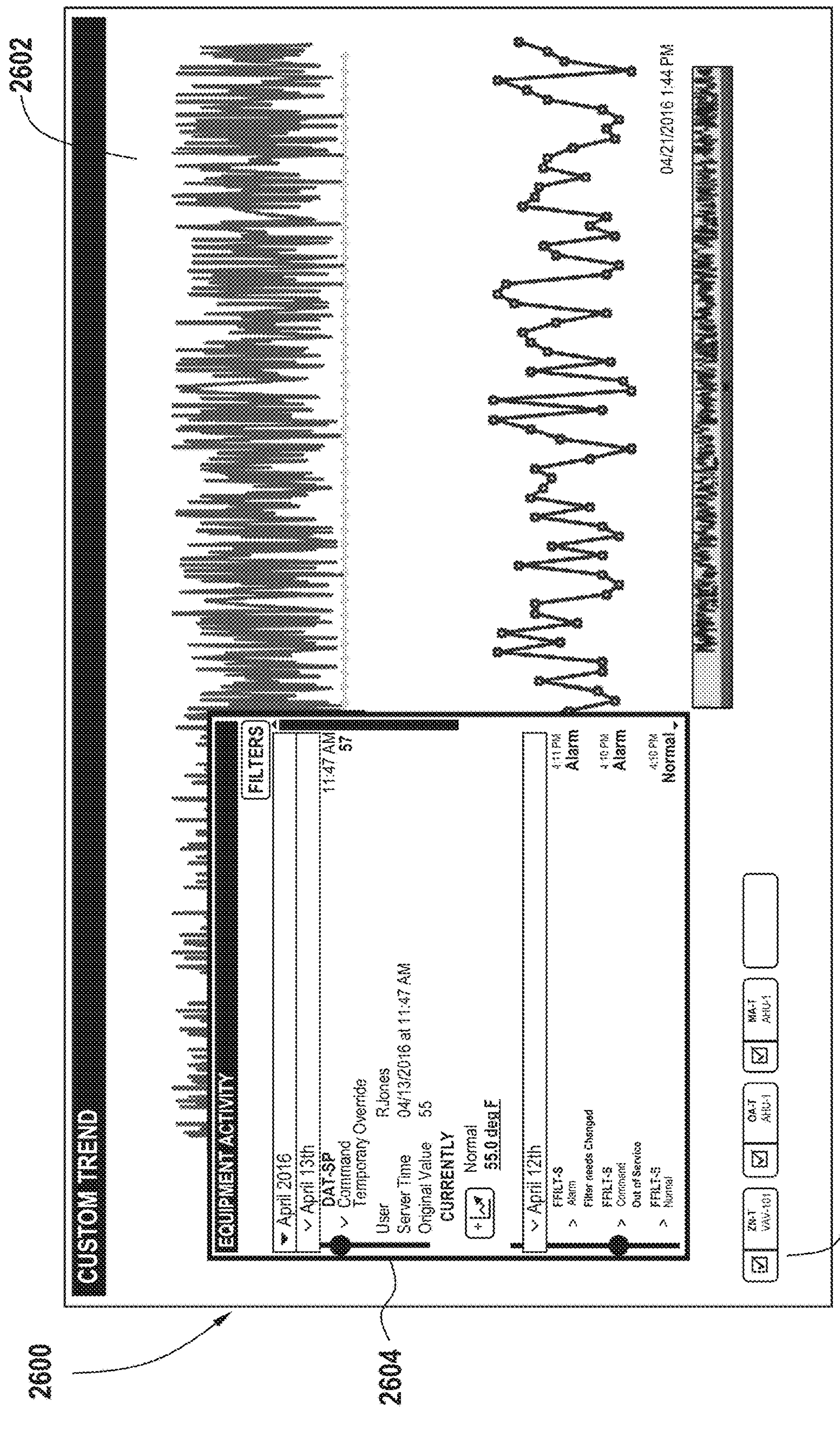

2500
2502
2504
2506
JCI Medical Center
Main Hospital
Floor 1
Conference Room
Front Lobby
Admin Area A
Admin Area B
Cafeteria A
Cafeteria B
Suite A
Suite B
Room 01
Room 02
Room 03
Room 04
Room 05
Team Room
Floor 1
Search
EQUIPMENT SUMMARY
VAV Boxes
EQUIPMENT SPACE(S) ZN-T ZN-T STATE FFFHTG-SP ZN-SP FFFCJG-SP WC-ADJ OCC-MODE SA-F
VAV-101 Conference Room 71.1 deg F Box Htg 74.0 deg F 72.0 deg F 78.0 deg F 4.0 deg F Occupied 0 cfm
VAV-102 Front Lobby 84.7 deg F Prmy Clg 74.0 deg F 72.0 deg F 78.0 deg F 4.0 deg F Occupied 0 cfm
VAV-103 Admin Area A 71.4 deg F Box Htg 72.0 deg F 72.0 deg F 76.0 deg F 2.0 deg F Occupied 0 cfm
VAV-104 Admin Area B 73.1 deg F Box Htg 74.0 deg F 72.0 deg F 78.0 deg F 4.0 deg F Occupied 0 cfm
VAV-105 Cafeteria A 72.5 deg F Box Htg 74.0 deg F 72.0 deg F 78.0 deg F 4.0 deg F Occupied 0 cfm
VAV-106 Cafeteria B 71.6 deg F Box Htg 74.0 deg F 72.0 deg F 78.0 deg F 4.0 deg F Occupied 0 cfm
VAV-107 Suite A 71.2 deg F Box Htg 72.0 deg F 72.0 deg F 76.0 deg F 2.0 deg F Occupied 0 cfm
VAV-108 Suite B 77.4 deg F Satisfied 61.0 deg F 72.0 deg F 82.0 deg F 4.0 deg F UnOccupied 0 cfm
VAV-109 Room 01 69.0 deg F Box Htg 72.0 deg F 72.0 deg F 76.0 deg F 2.0 deg F Occupied 0 cfm
VAV-110 Room 02 73.5 deg F Box Htg 74.0 deg F 72.0 deg F 78.0 deg F 4.0 deg F Occupied 0 cfm
VAV-111 Room 03 72.2 deg F Box Htg 74.0 deg F 72.0 deg F 78.0 deg F 4.0 deg F Occupied 0 cfm
VAV-112 Room 04 72.7 deg F Box Htg 74.0 deg F 72.0 deg F 78.0 deg F 4.0 deg F Occupied 0 cfm
VAV-113 Room 05 70.4 deg F Box Htg 74.0 deg F 72.0 deg F 78.0 deg F 4.0 deg F Occupied 0 cfm
VAV-114 Team Room 70.8 deg F Box Htg 74.0 deg F 72.0 deg F 78.0 deg F 4.0 deg F Occupied 0 cfm

FIG. 25



2600
2602
2604
2606
CUSTOM TREND
EQUIPMENT ACTIVITY
FILTERS
April 2016
April 13th
DAT-SP
Command
Temporary Override
11:47 AM
57
User R.Jones
Server Time 04/13/2016 at 11:47 AM
Original Value 55
CURRENTLY
Normal
55.0 deg F
April 12th
FFLT-S
Alarm
Filter needs Changed
4:11 PM
Alarm
FFLT-S
Command
Out of Service
4:10 PM
Alarm
FFLT-S
Normal
4:10 PM
Normal
ZN-T
VAV-101
OA-T
AHU-1
MA-T
AHU-1
04/21/2016 1:44 PM

FIG. 26

SYSTEMS AND METHODS FOR INTERFACING WITH A BUILDING MANAGEMENT SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This applications claims priority to and the benefit of Provisional U.S. Patent Application No. 62/336,520, filed May 13, 2016 and entitled "BUILDING MANAGEMENT SYSTEM USER INTERFACES," which is hereby incorporated in its entirety.

BACKGROUND

The present disclosure relates generally to the field of building management systems. A building management system (BMS) is, in general, a system of devices configured to control, monitor, and manage equipment in or around a building or building area. A BMS can include, for example, an HVAC system, a security system, a lighting system, a fire alerting system, any other system that is capable of managing building functions or devices, or any combination thereof. Specifically, the present disclosure relates to a user interface for use with a BMS, the user interface allowing for a user to easily interface with the BMS system as a whole.

SUMMARY

One implementation of the present disclosure is a building management system (BMS) interface system. The BMS interface system includes a user interface and a BMS controller in communication with the user interface. The BMS controller includes a processor. The processor is configured to display a graphical scheduling interface on the user interface and receive a scheduling input from the user interface. The processor is further configured to extract one or more scheduling elements from the received scheduling input and convert the scheduling elements into one or more BMS data objects. The processor is further configured to update the graphical scheduling interface displayed on the user interface. The processor is also configured to execute one or more scheduling instructions based on the received scheduling input, wherein the scheduling instructions are associated with the operation of one or more BMS devices.

A further implementation of the present disclosure is a method for scheduling one or more building management system (BMS) operations for a space. The method includes receiving a scheduling input from a user at a BMS controller and extracting one or more scheduling elements from the scheduling input. The method also includes converting the extracting scheduling elements into one or more BMS data objects and transmitting a schedule confirmation request to the user. The method also includes receiving a schedule confirmation from the user at the BMS controller and executing the confirmed schedule, wherein executing the confirmed schedule comprises operating one or more BMS devices based on the confirmed schedule.

A further implementation of the present disclosure is a building management system (BMS) graphical user interface system. The BMS graphical user interface system includes a user interface device, and a BMS controller in communication with the user interface device. The BMS controller includes a processor configured to automatically associate one or more BMS devices with a space. The processor is further configured to display a graphical scheduling interface for the space on the user interface device, wherein the graphical scheduling interface is configured to display an operational schedule for the one or more BMS devices associated with the space. The processor is further configured to receive a scheduling input from the user interface, wherein the scheduling input is one of a new schedule request and a schedule modification request. The processor is further configured to extract one or more scheduling elements from the received scheduling input and convert the scheduling elements into one or more BMS data objects, wherein the BMS data objects are data objects capable of being executed by the BMS controller. The processor is also configured to execute one or more scheduling instructions, wherein the scheduling instructions are associated with the operation of one or more BMS devices.

Those skilled in the art will appreciate that the summary is illustrative only and is not intended to be in any way limiting. Other aspects, inventive features, and advantages of the devices and/or processes described herein, as defined solely by the claims, will become apparent in the detailed description set forth herein and taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a drawing of a building equipped with a building management system (BMS) and a HVAC system, according to some embodiments.

FIG. **2** is a schematic of a waterside system which can be used as part of the HVAC system of FIG. **1**, according to some embodiments.

FIG. **3** is a block diagram of an airside system which can be used as part of the HVAC system of FIG. **1**, according to some embodiments.

FIG. **4** is a block diagram of a BMS which can be used in the building of FIG. **1**, according to some embodiments.

FIG. **5** is a block diagram illustrating a BMS controller associated with generating and controlling one or more graphical user interfaces (GUI), according to some embodiments.

FIG. **6** is a flow chart illustrating a process **600** for generating a schedule association cache, according to some embodiments.

FIG. **7** is an illustration of a facility-wide overview GUI, according to some embodiments.

FIG. **8** is an illustration of a building-wide overview GUI, according to some embodiments.

FIG. **9** is an illustration of a floor-wide overview GUI, according to some embodiments.

FIG. **10** is an illustration of a system-wide overview GUI, according to some embodiments.

FIG. **11** is an illustration of an alarm manager GUI showing a one week schedule, according to some embodiments.

FIG. **12** is an illustration of an alarm report, according to some embodiments.

FIG. **13** is an illustration of a schedule overview GUI, according to some embodiments.

FIG. **14** is an illustration of a location schedule GUI, according to some embodiments.

FIG. **15** is an illustration of a room effective schedule GUI, according to some embodiments.

FIG. **16** is an illustration of a room breakout schedule GUI, according to some embodiments.

FIG. **17** is an illustration of a schedule modification GUI, according to some embodiments.

FIG. **18** is a flow chart illustrating a process for processing a schedule modification or creation request, according to some embodiments.

FIG. **19** is a block diagram illustrating a system **1900** for converting extracted schedule elements into data objects, according to some embodiments.

FIG. **20** is an illustration of a schedule modification preview GUI, according to some embodiments.

FIG. **21** is an illustration of a potential problems interface GUI, according to some embodiments.

FIG. **22** is an illustration of a floor-level potential problems interface GUI, according to some embodiments.

FIG. **23** is an illustration of a floor equipment service space interface GUI, according to some embodiments.

FIG. **24** is an illustration of a room equipment serving space interface, according to some embodiments.

FIG. **25** is an illustration of an equipment serving space summary interface GUI, according to some embodiments.

FIG. **26** is an illustration of a data trend GUI, according to some embodiments.

DETAILED DESCRIPTION

Building Management System and HVAC System

Referring now to FIGS. **1-4**, an exemplary building management system (BMS) and HVAC system in which the systems and methods of the present disclosure can be implemented are shown, according to an exemplary embodiment. Referring particularly to FIG. **1**, a perspective view of a building **10** is shown. Building **10** is served by a BMS. A BMS is, in general, a system of devices configured to control, monitor, and manage equipment in or around a building or building area. A BMS can include, for example, a HVAC system, a security system, a lighting system, a fire alerting system, any other system that is capable of managing building functions or devices, or any combination thereof.

The BMS that serves building **10** includes an HVAC system **100**. HVAC system **100** can include a plurality of HVAC devices (e.g., heaters, chillers, air handling units, pumps, fans, thermal energy storage, etc.) configured to provide heating, cooling, ventilation, or other services for building **10**. For example, HVAC system **100** is shown to include a waterside system **120** and an airside system **130**. Waterside system **120** can provide a heated or chilled fluid to an air handling unit of airside system **130**. Airside system **130** can use the heated or chilled fluid to heat or cool an airflow provided to building **10**. An exemplary waterside system and airside system which can be used in HVAC system **100** are described in greater detail with reference to FIGS. **2-3**.

HVAC system **100** is shown to include a chiller **102**, a boiler **104**, and a rooftop air handling unit (AHU) **106**. Waterside system **120** can use boiler **104** and chiller **102** to heat or cool a working fluid (e.g., water, glycol, etc.) and can circulate the working fluid to AHU **106**. In various embodiments, the HVAC devices of waterside system **120** can be located in or around building **10** (as shown in FIG. **1**) or at an offsite location such as a central plant (e.g., a chiller plant, a steam plant, a heat plant, etc.). The working fluid can be heated in boiler **104** or cooled in chiller **102**, depending on whether heating or cooling is required in building **10**. Boiler **104** can add heat to the circulated fluid, for example, by burning a combustible material (e.g., natural gas) or using an electric heating element. Chiller **102** can place the circulated fluid in a heat exchange relationship with another fluid (e.g., a refrigerant) in a heat exchanger (e.g., an evaporator) to absorb heat from the circulated fluid. The working fluid from chiller **102** and/or boiler **104** can be transported to AHU **106** via piping **108**.

AHU **106** can place the working fluid in a heat exchange relationship with an airflow passing through AHU **106** (e.g., via one or more stages of cooling coils and/or heating coils). The airflow can be, for example, outside air, return air from within building **10**, or a combination of both. AHU **106** can transfer heat between the airflow and the working fluid to provide heating or cooling for the airflow. For example, AHU **106** can include one or more fans or blowers configured to pass the airflow over or through a heat exchanger containing the working fluid. The working fluid can then return to chiller **102** or boiler **104** via piping **110**.

Airside system **130** can deliver the airflow supplied by AHU **106** (i.e., the supply airflow) to building **10** via air supply ducts **112** and can provide return air from building **10** to AHU **106** via air return ducts **114**. In some embodiments, airside system **130** includes multiple variable air volume (VAV) units **116**. For example, airside system **130** is shown to include a separate VAV unit **116** on each floor or zone of building **10**. VAV units **116** can include dampers or other flow control elements that can be operated to control an amount of the supply airflow provided to individual zones of building **10**. In other embodiments, airside system **130** delivers the supply airflow into one or more zones of building **10** (e.g., via supply ducts **112**) without using intermediate VAV units **116** or other flow control elements. AHU **106** can include various sensors (e.g., temperature sensors, pressure sensors, etc.) configured to measure attributes of the supply airflow. AHU **106** can receive input from sensors located within AHU **106** and/or within the building zone and can adjust the flow rate, temperature, or other attributes of the supply airflow through AHU **106** to achieve set-point conditions for the building zone.

Referring now to FIG. **2**, a block diagram of a waterside system **200** is shown, according to an exemplary embodiment. In various embodiments, waterside system **200** can supplement or replace waterside system **120** in HVAC system **100** or can be implemented separate from HVAC system **100**. When implemented in HVAC system **100**, waterside system **200** can include a subset of the HVAC devices in HVAC system **100** (e.g., boiler **104**, chiller **102**, pumps, valves, etc.) and can operate to supply a heated or chilled fluid to AHU **106**. The HVAC devices of waterside system **200** can be located within building **10** (e.g., as components of waterside system **120**) or at an offsite location such as a central plant.

In FIG. **2**, waterside system **200** is shown as a central plant having a plurality of subplants **202-212**. Subplants **202-212** are shown to include a heater subplant **202**, a heat recovery chiller subplant **204**, a chiller subplant **206**, a cooling tower subplant **208**, a hot thermal energy storage (TES) subplant **210**, and a cold thermal energy storage (TES) subplant **212**. Subplants **202-212** consume resources (e.g., water, natural gas, electricity, etc.) from utilities to serve the thermal energy loads (e.g., hot water, cold water, heating, cooling, etc.) of a building or campus. For example, heater subplant **202** can be configured to heat water in a hot water loop **214** that circulates the hot water between heater subplant **202** and building **10**. Chiller subplant **206** can be configured to chill water in a cold water loop **216** that circulates the cold water between chiller subplant **206** building **10**. Heat recovery chiller subplant **204** can be configured to transfer heat from cold water loop **216** to hot water loop **214** to provide additional heating for the hot water and additional cooling for the cold water. Condenser water loop

218 can absorb heat from the cold water in chiller subplant 206 and reject the absorbed heat in cooling tower subplant 208 or transfer the absorbed heat to hot water loop 214. Hot TES subplant 210 and cold TES subplant 212 can store hot and cold thermal energy, respectively, for subsequent use.

Hot water loop 214 and cold water loop 216 can deliver the heated and/or chilled water to air handlers located on the rooftop of building 10 (e.g., AHU 106) or to individual floors or zones of building 10 (e.g., VAV units 116). The air handlers push air past heat exchangers (e.g., heating coils or cooling coils) through which the water flows to provide heating or cooling for the air. The heated or cooled air can be delivered to individual zones of building 10 to serve the thermal energy loads of building 10. The water then returns to subplants 202-212 to receive further heating or cooling.

Although subplants 202-212 are shown and described as heating and cooling water for circulation to a building, it is understood that any other type of working fluid (e.g., glycol, CO2, etc.) can be used in place of or in addition to water to serve the thermal energy loads. In other embodiments, subplants 202-212 can provide heating and/or cooling directly to the building or campus without requiring an intermediate heat transfer fluid. These and other variations to waterside system 200 are within the teachings of the present invention.

Each of subplants 202-212 can include a variety of equipment configured to facilitate the functions of the subplant. For example, heater subplant 202 is shown to include a plurality of heating elements 220 (e.g., boilers, electric heaters, etc.) configured to add heat to the hot water in hot water loop 214. Heater subplant 202 is also shown to include several pumps 222 and 224 configured to circulate the hot water in hot water loop 214 and to control the flow rate of the hot water through individual heating elements 220. Chiller subplant 206 is shown to include a plurality of chillers 232 configured to remove heat from the cold water in cold water loop 216. Chiller subplant 206 is also shown to include several pumps 234 and 236 configured to circulate the cold water in cold water loop 216 and to control the flow rate of the cold water through individual chillers 232.

Heat recovery chiller subplant 204 is shown to include a plurality of heat recovery heat exchangers 226 (e.g., refrigeration circuits) configured to transfer heat from cold water loop 216 to hot water loop 214. Heat recovery chiller subplant 204 is also shown to include several pumps 228 and 230 configured to circulate the hot water and/or cold water through heat recovery heat exchangers 226 and to control the flow rate of the water through individual heat recovery heat exchangers 226. Cooling tower subplant 208 is shown to include a plurality of cooling towers 238 configured to remove heat from the condenser water in condenser water loop 218. Cooling tower subplant 208 is also shown to include several pumps 240 configured to circulate the condenser water in condenser water loop 218 and to control the flow rate of the condenser water through individual cooling towers 238.

Hot TES subplant 210 is shown to include a hot TES tank 242 configured to store the hot water for later use. Hot TES subplant 210 can also include one or more pumps or valves configured to control the flow rate of the hot water into or out of hot TES tank 242. Cold TES subplant 212 is shown to include cold TES tanks 244 configured to store the cold water for later use. Cold TES subplant 212 can also include one or more pumps or valves configured to control the flow rate of the cold water into or out of cold TES tanks 244.

In some embodiments, one or more of the pumps in waterside system 200 (e.g., pumps 222, 224, 228, 230, 234, 236, and/or 240) or pipelines in waterside system 200 include an isolation valve associated therewith. Isolation valves can be integrated with the pumps or positioned upstream or downstream of the pumps to control the fluid flows in waterside system 200. In various embodiments, waterside system 200 can include more, fewer, or different types of devices and/or subplants based on the particular configuration of waterside system 200 and the types of loads served by waterside system 200.

Referring now to FIG. 3, a block diagram of an airside system 300 is shown, according to an exemplary embodiment. In various embodiments, airside system 300 can supplement or replace airside system 130 in HVAC system 100 or can be implemented separate from HVAC system 100. When implemented in HVAC system 100, airside system 300 can include a subset of the HVAC devices in HVAC system 100 (e.g., AHU 106, VAV units 116, ducts 112-114, fans, dampers, etc.) and can be located in or around building 10. Airside system 300 can operate to heat or cool an airflow provided to building 10 using a heated or chilled fluid provided by waterside system 200.

In FIG. 3, airside system 300 is shown to include an economizer-type air handling unit (AHU) 302. Economizer-type AHUs vary the amount of outside air and return air used by the air handling unit for heating or cooling. For example, AHU 302 can receive return air 304 from building zone 306 via return air duct 308 and can deliver supply air 310 to building zone 306 via supply air duct 312. In some embodiments, AHU 302 is a rooftop unit located on the roof of building 10 (e.g., AHU 106 as shown in FIG. 1) or otherwise positioned to receive both return air 304 and outside air 314. AHU 302 can be configured to operate exhaust air damper 316, mixing damper 318, and outside air damper 320 to control an amount of outside air 314 and return air 304 that combine to form supply air 310. Any return air 304 that does not pass through mixing damper 318 can be exhausted from AHU 302 through exhaust damper 316 as exhaust air 322.

Each of dampers 316-320 can be operated by an actuator. For example, exhaust air damper 316 can be operated by actuator 324, mixing damper 318 can be operated by actuator 326, and outside air damper 320 can be operated by actuator 328. Actuators 324-328 can communicate with an AHU controller 330 via a communications link 332. Actuators 324-328 can receive control signals from AHU controller 330 and can provide feedback signals to AHU controller 330. Feedback signals can include, for example, an indication of a current actuator or damper position, an amount of torque or force exerted by the actuator, diagnostic information (e.g., results of diagnostic tests performed by actuators 324-328), status information, commissioning information, configuration settings, calibration data, and/or other types of information or data that can be collected, stored, or used by actuators 324-328. AHU controller 330 can be an economizer controller configured to use one or more control algorithms (e.g., state-based algorithms, extremum seeking control (ESC) algorithms, proportional-integral (PI) control algorithms, proportional-integral-derivative (PID) control algorithms, model predictive control (MPC) algorithms, feedback control algorithms, etc.) to control actuators 324-328.

Still referring to FIG. 3, AHU 302 is shown to include a cooling coil 334, a heating coil 336, and a fan 338 positioned within supply air duct 312. Fan 338 can be configured to force supply air 310 through cooling coil 334 and/or heating coil 336 and provide supply air 310 to building zone 306. AHU controller 330 can communicate with fan 338 via communications link 340 to control a flow rate of supply air

310. In some embodiments, AHU controller **330** controls an amount of heating or cooling applied to supply air **310** by modulating a speed of fan **338**.

Cooling coil **334** can receive a chilled fluid from waterside system **200** (e.g., from cold water loop **216**) via piping **342** and can return the chilled fluid to waterside system **200** via piping **344**. Valve **346** can be positioned along piping **342** or piping **344** to control a flow rate of the chilled fluid through cooling coil **334**. In some embodiments, cooling coil **334** includes multiple stages of cooling coils that can be independently activated and deactivated (e.g., by AHU controller **330**, by BMS controller **366**, etc.) to modulate an amount of cooling applied to supply air **310**.

Heating coil **336** can receive a heated fluid from waterside system **200** (e.g., from hot water loop **214**) via piping **348** and can return the heated fluid to waterside system **200** via piping **350**. Valve **352** can be positioned along piping **348** or piping **350** to control a flow rate of the heated fluid through heating coil **336**. In some embodiments, heating coil **336** includes multiple stages of heating coils that can be independently activated and deactivated (e.g., by AHU controller **330**, by BMS controller **366**, etc.) to modulate an amount of heating applied to supply air **310**.

Each of valves **346** and **352** can be controlled by an actuator. For example, valve **346** can be controlled by actuator **354** and valve **352** can be controlled by actuator **356**. Actuators **354-356** can communicate with AHU controller **330** via communications links **358-360**. Actuators **354-356** can receive control signals from AHU controller **330** and can provide feedback signals to controller **330**. In some embodiments, AHU controller **330** receives a measurement of the supply air temperature from a temperature sensor **362** positioned in supply air duct **312** (e.g., downstream of cooling coil **334** and/or heating coil **336**). AHU controller **330** can also receive a measurement of the temperature of building zone **306** from a temperature sensor **364** located in building zone **306**.

In some embodiments, AHU controller **330** operates valves **346** and **352** via actuators **354-356** to modulate an amount of heating or cooling provided to supply air **310** (e.g., to achieve a set-point temperature for supply air **310** or to maintain the temperature of supply air **310** within a set-point temperature range). The positions of valves **346** and **352** affect the amount of heating or cooling provided to supply air **310** by cooling coil **334** or heating coil **336** and may correlate with the amount of energy consumed to achieve a desired supply air temperature. AHU controller **330** can control the temperature of supply air **310** and/or building zone **306** by activating or deactivating coils **334-336**, adjusting a speed of fan **338**, or a combination of both.

Still referring to FIG. **3**, airside system **300** is shown to include a building management system (BMS) controller **366** and a client device **368**. BMS controller **366** can include one or more computer systems (e.g., servers, supervisory controllers, subsystem controllers, etc.) that serve as system level controllers, application or data servers, head nodes, or master controllers for airside system **300**, waterside system **200**, HVAC system **100**, and/or other controllable systems that serve building **10**. BMS controller **366** can communicate with multiple downstream building systems or subsystems (e.g., HVAC system **100**, a security system, a lighting system, waterside system **200**, etc.) via a communications link **370** according to like or disparate protocols (e.g., LON, BACnet, etc.). In various embodiments, AHU controller **330** and BMS controller **366** can be separate (as shown in FIG. **3**) or integrated. In an integrated implementation, AHU controller **330** can be a software module configured for execution by a processor of BMS controller **366**.

In some embodiments, AHU controller **330** receives information from BMS controller **366** (e.g., commands, setpoints, operating boundaries, etc.) and provides information to BMS controller **366** (e.g., temperature measurements, valve or actuator positions, operating statuses, diagnostics, etc.). For example, AHU controller **330** can provide BMS controller **366** with temperature measurements from temperature sensors **362-364**, equipment on/off states, equipment operating capacities, and/or any other information that can be used by BMS controller **366** to monitor or control a variable state or condition within building zone **306**.

Client device **368** can include one or more human-machine interfaces or client interfaces (e.g., graphical user interfaces, reporting interfaces, text-based computer interfaces, client-facing web services, web servers that provide pages to web clients, etc.) for controlling, viewing, or otherwise interacting with HVAC system **100**, its subsystems, and/or devices. Client device **368** can be a computer workstation, a client terminal, a remote or local interface, or any other type of user interface device. Client device **368** can be a stationary terminal or a mobile device. For example, client device **368** can be a desktop computer, a computer server with a user interface, a laptop computer, a tablet, a smartphone, a PDA, or any other type of mobile or non-mobile device. Client device **368** can communicate with BMS controller **366** and/or AHU controller **330** via communications link **372**.

Referring now to FIG. **4**, a block diagram of a building management system (BMS) **400** is shown, according to an exemplary embodiment. BMS **400** can be implemented in building **10** to automatically monitor and control various building functions. BMS **400** is shown to include BMS controller **366** and a plurality of building subsystems **428**. Building subsystems **428** are shown to include a building electrical subsystem **434**, an information communication technology (ICT) subsystem **436**, a security subsystem **438**, a HVAC subsystem **440**, a lighting subsystem **442**, a lift/escalators subsystem **432**, and a fire safety subsystem **430**. In various embodiments, building subsystems **428** can include fewer, additional, or alternative subsystems. For example, building subsystems **428** can also or alternatively include a refrigeration subsystem, an advertising or signage subsystem, a cooking subsystem, a vending subsystem, a printer or copy service subsystem, or any other type of building subsystem that uses controllable equipment and/or sensors to monitor or control building **10**. In some embodiments, building subsystems **428** include waterside system **200** and/or airside system **300**, as described with reference to FIGS. **2-3**.

Each of building subsystems **428** can include any number of devices, controllers, and connections for completing its individual functions and control activities. HVAC subsystem **440** can include many of the same components as HVAC system **100**, as described with reference to FIGS. **1-3**. For example, HVAC subsystem **440** can include a chiller, a boiler, any number of air handling units, economizers, field controllers, supervisory controllers, actuators, temperature sensors, and other devices for controlling the temperature, humidity, airflow, or other variable conditions within building **10**. Lighting subsystem **442** can include any number of light fixtures, ballasts, lighting sensors, dimmers, or other devices configured to controllably adjust the amount of light provided to a building space. Security subsystem **438** can include occupancy sensors, video surveillance cameras, digital video recorders, video processing servers, intrusion detection devices, access control devices (e.g., card access, etc.) and servers, or other security-related devices.

Still referring to FIG. **4**, BMS controller **366** is shown to include a communications interface **407** and a BMS interface **409**. Interface **407** can facilitate communications between BMS controller **366** and external applications (e.g., monitoring and reporting applications **422**, enterprise control applications **426**, remote systems and applications **444**, applications residing on client devices **448**, etc.) for allowing user control, monitoring, and adjustment to BMS controller **366** and/or subsystems **428**. Interface **407** can also facilitate communications between BMS controller **366** and client devices **448**. BMS interface **409** can facilitate communications between BMS controller **366** and building subsystems **428** (e.g., HVAC, lighting security, lifts, power distribution, business, etc.).

Interfaces **407**, **409** can be or include wired or wireless communications interfaces (e.g., jacks, antennas, transmitters, receivers, transceivers, wire terminals, etc.) for conducting data communications with building subsystems **428** or other external systems or devices. In various embodiments, communications via interfaces **407**, **409** can be direct (e.g., local wired or wireless communications) or via a communications network **446** (e.g., a WAN, the Internet, a cellular network, etc.). For example, interfaces **407**, **409** can include an Ethernet card and port for sending and receiving data via an Ethernet-based communications link or network. In another example, interfaces **407**, **409** can include a Wi-Fi transceiver for communicating via a wireless communications network. In another example, one or both of interfaces **407**, **409** can include cellular or mobile phone communications transceivers. In one embodiment, communications interface **407** is a power line communications interface and BMS interface **409** is an Ethernet interface. In other embodiments, both communications interface **407** and BMS interface **409** are Ethernet interfaces or are the same Ethernet interface.

Still referring to FIG. **4**, BMS controller **366** is shown to include a processing circuit **404** including a processor **406** and memory **408**. Processing circuit **404** can be communicably connected to BMS interface **409** and/or communications interface **407** such that processing circuit **404** and the various components thereof can send and receive data via interfaces **407**, **409**. Processor **406** can be implemented as a general purpose processor, an application specific integrated circuit (ASIC), one or more field programmable gate arrays (FPGAs), a group of processing components, or other suitable electronic processing components.

Memory **408** (e.g., memory, memory unit, storage device, etc.) can include one or more devices (e.g., RAM, ROM, Flash memory, hard disk storage, etc.) for storing data and/or computer code for completing or facilitating the various processes, layers and modules described in the present application. Memory **408** can be or include volatile memory or non-volatile memory. Memory **408** can include database components, object code components, script components, or any other type of information structure for supporting the various activities and information structures described in the present application. According to an exemplary embodiment, memory **408** is communicably connected to processor **406** via processing circuit **404** and includes computer code for executing (e.g., by processing circuit **404** and/or processor **406**) one or more processes described herein.

In some embodiments, BMS controller **366** is implemented within a single computer (e.g., one server, one housing, etc.). In various other embodiments BMS controller **366** can be distributed across multiple servers or computers (e.g., that can exist in distributed locations). Further, while FIG. **4** shows applications **422** and **426** as existing outside of BMS controller **366**, in some embodiments, applications **422** and **426** can be hosted within BMS controller **366** (e.g., within memory **408**).

Still referring to FIG. **4**, memory **408** is shown to include an enterprise integration layer **410**, an automated measurement and validation (AM&V) layer **412**, a demand response (DR) layer **414**, a fault detection and diagnostics (FDD) layer **416**, an integrated control layer **418**, and a building subsystem integration later **420**. Layers **410**-**420** can be configured to receive inputs from building subsystems **428** and other data sources, determine optimal control actions for building subsystems **428** based on the inputs, generate control signals based on the optimal control actions, and provide the generated control signals to building subsystems **428**. The following paragraphs describe some of the general functions performed by each of layers **410**-**420** in BMS **400**.

Enterprise integration layer **410** can be configured to serve clients or local applications with information and services to support a variety of enterprise-level applications. For example, enterprise control applications **426** can be configured to provide subsystem-spanning control to a graphical user interface (GUI) or to any number of enterprise-level business applications (e.g., accounting systems, user identification systems, etc.). Enterprise control applications **426** can also or alternatively be configured to provide configuration GUIs for configuring BMS controller **366**. In yet other embodiments, enterprise control applications **426** can work with layers **410**-**420** to optimize building performance (e.g., efficiency, energy use, comfort, or safety) based on inputs received at interface **407** and/or BMS interface **409**.

Building subsystem integration layer **420** can be configured to manage communications between BMS controller **366** and building subsystems **428**. For example, building subsystem integration layer **420** can receive sensor data and input signals from building subsystems **428** and provide output data and control signals to building subsystems **428**. Building subsystem integration layer **420** can also be configured to manage communications between building subsystems **428**. Building subsystem integration layer **420** translate communications (e.g., sensor data, input signals, output signals, etc.) across a plurality of multi-vendor/multi-protocol systems.

Demand response layer **414** can be configured to optimize resource usage (e.g., electricity use, natural gas use, water use, etc.) and/or the monetary cost of such resource usage in response to satisfy the demand of building **10**. The optimization can be based on time-of-use prices, curtailment signals, energy availability, or other data received from utility providers, distributed energy generation systems **424**, from energy storage **427** (e.g., hot TES **242**, cold TES **244**, etc.), or from other sources. Demand response layer **414** can receive inputs from other layers of BMS controller **366** (e.g., building subsystem integration layer **420**, integrated control layer **418**, etc.). The inputs received from other layers can include environmental or sensor inputs such as temperature, carbon dioxide levels, relative humidity levels, air quality sensor outputs, occupancy sensor outputs, room schedules, and the like. The inputs can also include inputs such as electrical use (e.g., expressed in kWh), thermal load measurements, pricing information, projected pricing, smoothed pricing, curtailment signals from utilities, and the like.

According to an exemplary embodiment, demand response layer **414** includes control logic for responding to the data and signals it receives. These responses can include communicating with the control algorithms in integrated control layer **418**, changing control strategies, changing setpoints, or activating/deactivating building equipment or subsystems in a controlled manner. Demand response layer **414** can also include control logic configured to determine when to utilize stored energy. For example, demand response layer **414** can determine to begin using energy from energy storage **427** just prior to the beginning of a peak use hour.

In some embodiments, demand response layer **414** includes a control module configured to actively initiate control actions (e.g., automatically changing setpoints) which minimize energy costs based on one or more inputs representative of or based on demand (e.g., price, a curtailment signal, a demand level, etc.). In some embodiments, demand response layer **414** uses equipment models to determine an optimal set of control actions. The equipment models can include, for example, thermodynamic models describing the inputs, outputs, and/or functions performed by various sets of building equipment. Equipment models can represent collections of building equipment (e.g., subplants, chiller arrays, etc.) or individual devices (e.g., individual chillers, heaters, pumps, etc.).

Demand response layer **414** can further include or draw upon one or more demand response policy definitions (e.g., databases, XML files, etc.). The policy definitions can be edited or adjusted by a user (e.g., via a graphical user interface) so that the control actions initiated in response to demand inputs can be tailored for the user's application, desired comfort level, particular building equipment, or based on other concerns. For example, the demand response policy definitions can specify which equipment can be turned on or off in response to particular demand inputs, how long a system or piece of equipment should be turned off, what setpoints can be changed, what the allowable set point adjustment range is, how long to hold a high demand set-point before returning to a normally scheduled set-point, how close to approach capacity limits, which equipment modes to utilize, the energy transfer rates (e.g., the maximum rate, an alarm rate, other rate boundary information, etc.) into and out of energy storage devices (e.g., thermal storage tanks, battery banks, etc.), and when to dispatch on-site generation of energy (e.g., via fuel cells, a motor generator set, etc.).

Integrated control layer **418** can be configured to use the data input or output of building subsystem integration layer **420** and/or demand response later **414** to make control decisions. Due to the subsystem integration provided by building subsystem integration layer **420**, integrated control layer **418** can integrate control activities of the subsystems **428** such that the subsystems **428** behave as a single integrated supersystem. In an exemplary embodiment, integrated control layer **418** includes control logic that uses inputs and outputs from a plurality of building subsystems to provide greater comfort and energy savings relative to the comfort and energy savings that separate subsystems could provide alone. For example, integrated control layer **418** can be configured to use an input from a first subsystem to make an energy-saving control decision for a second subsystem. Results of these decisions can be communicated back to building subsystem integration layer **420**.

Integrated control layer **418** is shown to be logically below demand response layer **414**. Integrated control layer **418** can be configured to enhance the effectiveness of demand response layer **414** by enabling building subsystems **428** and their respective control loops to be controlled in coordination with demand response layer **414**. This configuration may advantageously reduce disruptive demand response behavior relative to conventional systems. For example, integrated control layer **418** can be configured to assure that a demand response-driven upward adjustment to the set-point for chilled water temperature (or another component that directly or indirectly affects temperature) does not result in an increase in fan energy (or other energy used to cool a space) that would result in greater total building energy use than was saved at the chiller.

Integrated control layer **418** can be configured to provide feedback to demand response layer **414** so that demand response layer **414** checks that constraints (e.g., temperature, lighting levels, etc.) are properly maintained even while demanded load shedding is in progress. The constraints can also include set-point or sensed boundaries relating to safety, equipment operating limits and performance, comfort, fire codes, electrical codes, energy codes, and the like. Integrated control layer **418** is also logically below fault detection and diagnostics layer **416** and automated measurement and validation layer **412**. Integrated control layer **418** can be configured to provide calculated inputs (e.g., aggregations) to these higher levels based on outputs from more than one building subsystem.

Automated measurement and validation (AM&V) layer **412** can be configured to verify that control strategies commanded by integrated control layer **418** or demand response layer **414** are working properly (e.g., using data aggregated by AM&V layer **412**, integrated control layer **418**, building subsystem integration layer **420**, FDD layer **416**, or otherwise). The calculations made by AM&V layer **412** can be based on building system energy models and/or equipment models for individual BMS devices or subsystems. For example, AM&V layer **412** can compare a model-predicted output with an actual output from building subsystems **428** to determine an accuracy of the model.

Fault detection and diagnostics (FDD) layer **416** can be configured to provide on-going fault detection for building subsystems **428**, building subsystem devices (i.e., building equipment), and control algorithms used by demand response layer **414** and integrated control layer **418**. FDD layer **416** can receive data inputs from integrated control layer **418**, directly from one or more building subsystems or devices, or from another data source. FDD layer **416** can automatically diagnose and respond to detected faults. The responses to detected or diagnosed faults can include providing an alert message to a user, a maintenance scheduling system, or a control algorithm configured to attempt to repair the fault or to work-around the fault.

FDD layer **416** can be configured to output a specific identification of the faulty component or cause of the fault (e.g., loose damper linkage) using detailed subsystem inputs available at building subsystem integration layer **420**. In other exemplary embodiments, FDD layer **416** is configured to provide "fault" events to integrated control layer **418** which executes control strategies and policies in response to the received fault events. According to an exemplary embodiment, FDD layer **416** (or a policy executed by an integrated control engine or business rules engine) can shut-down systems or direct control activities around faulty devices or systems to reduce energy waste, extend equipment life, or assure proper control response.

FDD layer **416** can be configured to store or access a variety of different system data stores (or data points for live data). FDD layer **416** can use some content of the data stores to identify faults at the equipment level (e.g., specific chiller, specific AHU, specific terminal unit, etc.) and other content to identify faults at component or subsystem levels. For example, building subsystems **428** can generate temporal (i.e., time-series) data indicating the performance of BMS **400** and the various components thereof. The data generated by building subsystems **428** can include measured or calculated values that exhibit statistical characteristics and provide information about how the corresponding system or process (e.g., a temperature control process, a flow control process, etc.) is performing in terms of error from its set-point. These processes can be examined by FDD layer **416** to expose when the system begins to degrade in performance and alert a user to repair the fault before it becomes more severe.

Graphical User Interfaces of the BMS Building Management System

FIG. **5** is a block diagram illustrating a BMS controller **500** associated with generating and controlling one or more graphical user interfaces. The BMS controller **500** may include a processing circuit **502**, a user interface **504** and a communication interface **506**. The processing circuit **502** may include a processor **508** and a memory **510**. The processor **508** may be a general purpose or specific purpose processor, an application specific integrated circuit (ASIC), one or more field programmable gate arrays (FPGAs), a group of processing components, or other suitable processing components. The processor **508** may be configured to execute computer code or instructions stored in memory **510** or received from other computer readable media (e.g., CDROM, network storage, a remote server, etc.).

The memory **510** may include one or more devices (e.g., memory units, memory devices, storage devices, etc.) for storing data and/or computer code for completing and/or facilitating the various processes described in the present disclosure. The memory **510** may include random access memory (RAM), read-only memory (ROM), hard drive storage, temporary storage, non-volatile memory, flash memory, optical memory, or any other suitable memory for storing software objects and/or computer instructions. The memory **510** may include database components, object code components, script components, or any other type of information structure for supporting the various activities and information structures described in the present disclosure. The memory **510** may be communicably connected to the processor **508** and may include computer code for executing (e.g. by processor **508**) one or more processes described herein.

The memory **510** may include a visualization module **512**, an alarm manager module **514**, a scheduling module **516**, a problem detection module **518**, an equipment service space module **520**, a data analytics module **522**, and an association module **524**. The function and operation of the above described modules will be described in detail below.

The user interface **504** may be used to provide a visualization related to a BMS to a user. In one embodiment, the user interface **504** may be a touch screen interface, such as a capacitive or resistive touch screen interface. In other embodiments, the user interface **504** is a visual display in combination with an input device. Example input devices may include keyboards, keypads, switches, touch screen interfaces (e.g. capacitive or resistive), or other devices which allow a user to input data into the BMS controller **500**. The user interface **504** may further be a combination of devices described above. The user interface **504** may be configured to allow a user to interface with the BMS controller **500**.

The communication interface **506** may include wired or wireless interfaces (e.g. jacks, antennas, transmitters, receivers, transceivers, wire terminals, etc.) for conducting data communications with various systems, devices, or networks. For example, the communication interface **506** may include an Ethernet card and port for sending and receiving data via an Ethernet-based communications network. The communication interface **506** may be configured to communicate via local area networks or wide area networks, (e.g., the Internet, a building WAN, etc.) and may use a variety of communications protocols (e.g., BACnet, IP, LON, etc.). In one embodiment, the communication interface **506** may include one or more wireless radio transceivers. For example, the communication interface **506** may include a Wi-Fi transceiver. In other embodiments, the communication interface **506** may include other wireless transceivers, such as a LoRa transceiver, a Bluetooth transceiver, a near field communication (NFC) transceiver, a cellular transceiver (3G, 4G, LTE, CDMA), a Wi-Max transceiver, or other applicable wireless transceivers.

In one embodiment, the communication interface **506** may be configured to communicate with a cloud-based server **526**. The cloud-based server **526** may include one or more databases, which can be accessed by the BMS controller **500** via the communication interface. The cloud-based server **526** may be configured to be access via an internet connection. In other examples, the cloud-based server **526** may be a dedicated cloud-based service within a BMS. The communication interface **506** may further be configured to communicate with a remote user interface **528**. The remote user interface **528** may be a terminal or other device capable of accessing the BMS controller **500** via the communication interface **506**. In some embodiments, the remote user interface **528** may be a user device, such as a personal computer (PC), a laptop computer, a smartphone, a tablet computer, and the like. The remote user interface **528** may further be configured to communicate the cloud-based server **526**. For example, the remote user interface **528** may have an internet access which allows the remote user interface **528** to access the BMS controller **500** via the cloud-based server **526**. For example, the remote user interface **528** may utilize a web-server to allow a user to interface with the BMS controller via the cloud-based server **526**.

In one embodiment, the visualization module **512** may be configured to generate one or more graphical user interfaces (GUI), such as those described below. The visualization module **512** may be configured to display the generated GUIs on the user interface **504**. In other embodiments, the visualization module **512** may provide the GUIs to the cloud-based server **526** where they may be displayed to a user accessing the cloud-based server **526**. In some embodiments, the cloud-based server **526** may provide the generated GUIs in a web-based interface (e.g. HTML 5). Thus, a user may be able to access the GUIs using a web-browser. In some embodiments, the user may view the GUIs using a remote user interface, such as remote user interface **528**.

The association module **524** may be configured to associate one or more pieces of equipment in a BMS, such as those described in FIGS. **1-4** above, with a space within the BMS. Example spaces can include a campus, a building, a zone within a building, a room within a building, or any space services by one or more pieces of BMS equipment. In one embodiment, the association module **524** is in communication with one or more databases associated with a BMS. For example, the association module **524** may access one or more databases stored in the cloud-based server **526**. In one embodiment, the association module **524** may include a system configuration tool which can automatically generate associations between BMS equipment and a space. The association module **524** may make the associations at the equipment level (e.g. via attributes of the equipment objects). In one embodiment, the association module **524** performs the associations when the BMS controller **500** is in an offline condition. For example, the association module **524** may query a database within the cloud-based server instead of attempting to query all of the equipment directly. The association module **524** may include logic to automatically associate one or more pieces of BMS equipment with a given space. For example, the association module **524** may evaluate locations and data points associated with the equipment, and further evaluate which data points are associated with the space. In other embodiments, a database may include data describing which pieces of equipment service a given space, or are located within a given space. The association module **524** may extract this information to automatically associate the equipment with one or more spaces.

In one embodiment, the association module **524** may be configured to generate one or more associations between equipment and one or more schedules. The association module **524** may populate an equipment cache stored in the memory **510** with the determined relationships described above. The association module **524** may evaluate scheduling entities, such as calendar entities and schedule entities and associate them with one or more equipment entities. The schedule entities and the calendar entities may serve as containers for long living sets of information, such as weekly schedule and calendar entries. The schedule entities and calendar entities may further serve as anchors for keeping one or more attributes registered for and updated within a read attribute service cache, which may be stored in the memory **510**.

FIG. **6** is a flow chart illustrating a process **600** for generating a schedule association cache is shown. At process block **602**, the cache is generated based on information provided by the above described system configuration tool. In one embodiment, the system configuration tool may be within the association module **524**. In other embodiments, the system configuration tool may be external to the BMS controller **500**, such as in the cloud-based server **526** and/or the remote user interface **528**. For example, a user may be able to access the system configuration tool via the cloud-based server **5226** using the remote user interface **528**. The cache may further be populated with additional information required to create the equipment associations. The additional information may include equipment location, equipment data points, system layouts, etc.

At process block **604**, associations between the BMS equipment and one or more schedules are generated. In one example, the association module **524** may automatically generate the associations based on the information in the cache generated at process block **602**. Finally, at process block **604**, changes of values (COVs) associated with the schedule entities and the calendar entities are registered.

The following figures relate to various graphical user interfaces (GUI) provided by the BMS controller **500**. In one embodiment, the BMS controller **500** generates the various graphical user interfaces via the visualization module **512**. The visualization module **512** may use a web-server to generate the graphical user interfaces in a web-page (i.e. HTML5) format. Alternatively, the visualization module **512** may include a dedicated device running software associated with the graphical user interface. Where the graphical user interfaces are generated using a web-server, the graphics, as well as the associated user interfaces may not require any software or plugin to be installed on a client device, such as remote user interface **528**. In one embodiment, the visualization module **512** can provide the same graphic to multiple client devices, regardless of the client device type.

Referring now to FIG. **7**, a facility-wide overview GUI **700** is shown, according to one embodiment. The facility-wide overview GUI **700** may include a visual representation **702** of an entire facility or campus. The facility-wide overview GUI **700** may include multiple independent buildings that a user can select within the visual representation **702**. The facility-wide overview GUI **700** may further include general facility data **704**. For example, outside temperature and humidity may be possible general facility data **704** that can be displayed in the facility-wide overview GUI **700**. Further, the facility-wide overview GUI **700** may include a facility selection tool **706**. The facility selection tool **706** may be configured to allow a user to switch between multiple facilities. In one embodiment, the facility selection tool **706** can include multiple arrows or other selection devices that can allow the user to scroll through multiple facilities. In one example, each of the available facilities may be controlled by a single BMS controller, such as BMS controller **500**. However, in other examples, each available facility may be controlled by one or more BMS controllers **500**.

The facility-wide overview GUI **700** may further include an alarm indicator **708**, a search bar **710** and a trend data icon **712**. In one embodiment, the alarm indicator **708** provides an alert to the user that an alarm is present in the facility shown in the visual representation **702**. However, in other embodiments the alarm indicator **708** may provide an indication to the user that an alert has occurred in one or more of the available facilities. The user can select the alarm indicator **708**, which may activate an alarm summary GUI, as described in more detail below. The search bar **710** allows a user to type in a search to the facility-wide overview GUI **700**. In one embodiment, the search bar **710** can be used to search for any building, floor, room, or device in a BMS, such as BMS **400**. In one embodiment, the search bar **710** can allow for natural language searching to allow for easier access to the search functionality of the facility-wide overview GUI **700** for users unfamiliar with the BMS. Further, in some embodiments, a user may be able to use the search bar **710** to search for tutorials, help functions, user manuals, etc. associated with the facility-wide overview GUI **700** and/or the BMS. In one embodiment, the search bar **710** is limited to items located within the particular GUI. For example, the search bar **710** in the facility-wide overview GUI **700** may search all items within the displayed facility. However, in other embodiments, the search bar **710** may provide a search of all the available facilities. Finally, the trend data icon **712** can be selected by a user to bring up a trend data GUI, discussed in more detail below.

While the alarm indicator **708**, the search bar **710** and the trend data icon **712** are discussed in context of the facility-wide overview GUI **700**, these features may be present within multiple GUIs, as will be seen in the following figures. Unless discussed otherwise, it is to be understood that the functionality of the alarm indicator **708**, the search bar **710**, and the trend data icon **712** is similar for each GUI.

Turning now to FIG. **8**, a building-wide overview GUI **800** is shown, according to one embodiment. The building-wide overview GUI **800** can provide a building overview interface **802** of the building referenced in the building-wide overview GUI **800**. In one embodiment, the building is a building selected from the facility-wide overview GUI **700** described above. The building overview interface **802** can include a building floor listing **804**. The building floor listing **804** may provide an indication of data associated with each floor within the building. For example, the building floor listings **804** may provide an indication of alarms, equipment, rooms, etc., for each floor within the building. In one embodiment, a user can select one or more of the floors listed in the building floor listing **804** to access a GUI associated with the selected floor, as will be discussed in more detail below.

The building-wide overview GUI **800** may further include a primary systems interface **806**. The primary systems interface **806** can provide a visual representation of the primary systems and associated equipment associated with the building. Example primary systems can include HVAC systems chiller plants, central heating systems, heat exchanges, air handling units (AHUs), etc., as well as other building systems such as lighting, water quality, etc. In one embodiment, the primary systems interface **806** provides a status for each of the systems and the associated equipment. For example, the primary systems interface **806** may provide an on or off status for the chillers associated with the central chiller plant, and the boilers associated with the central heating system. In other examples, information such as water temperature at the output of the heat exchanges or discharge air temperatures for air handling units may further be displayed. In one embodiment, a user can select one of the individual primary systems or an individual device to access a GUI associated with that system or device, as will be described in more detail below.

The building-wide overview GUI **800** may further include a summary window **808**. In one embodiment, the summary window **808** is a customized summary created to provide a user with quick access to important information relating to the building. For example, the summary window **808** of FIG. **6** is shown to include a number of alarms **810** and a number of freezer temperatures **812**. In one embodiment, a user can select any of the alarms **810** or the freezer temperature **812** to access a GUI associated with the individual alarm or device, as will be described in more detail below. In a further example, the summary window **808** may be dynamically generated by the visualization module **512** to display the most relevant data. For example, active alarms, or systems/device designated within the BMS controller **500** as critical may be automatically displayed in the summary window **808**.

Turning now to FIG. **9**, a floor-wide overview GUI **900** is shown, according to one embodiment. The floor wide overview GUI **900** includes a floor overview interface **902**. In one example, the floor displayed in the floor overview interface **902** is a floor selected from the building-wide overview GUI **800** described above. In one embodiment, the floor overview interface **902** displays a number or rooms and systems associated with the floor. In one example, data may be displayed that is associated with each room on the floor. For example, each room displayed in the floor overview interface **902** may have an associated temperature of the room displayed. However, other information such as active alarms, temperature set points, abnormal temperatures, etc. may also be displayed. In one embodiment, a representation of the ductwork associated with the floor may be displayed. A device listing **904** may also be provided on the floor overview interface **902**. The device listing **904** may provide a list of all systems or devices located on the floor. In other examples, the device listing **904** may provide a list of all systems or devices that provide service to the floor.

Turning now to FIG. **10**, a system-wide overview GUI **1000** is shown, according to one embodiment. The system-wide overview GUI **1000** includes a system overview interface **1002**. In one example, the system displayed in the system overview interface **1002** is a system selected from the floor-wide overview GUI **900** described above. However, the system displayed in the system overview interface **1002** may be a system selected in the building-wide overview GUI **800** or the facility-wide overview GUI **700**. The system overview interface **1002** may include a system summary display **1004**. In one embodiment, the system summary display **1004** displays one or more settings associated with the system. For example, settings such as setpoint temperatures, airflows, operating times, etc. may be displayed in the system summary display **1004**. Further, one or more device status indicators **1006** may be displayed in the system overview interface **1002**. In one embodiment, a user can select one or more of the device status indicators **1006** to generate a detailed device GUI relating to the selected device status. The system overview interface **1002** may further include one or more system status indicators **1008**. The system status indicators **1008** can provide various system based status information to a user. In one example, the system status indicators **1008** can provide status information such as intake air temperature, discharge air temperature, intake water temperature, discharge water temperature, fan speed, etc.

Turning now to FIG. **11**, an alarm manager GUI **1100** is shown, according to one embodiment. In one embodiment, the alarm manager module **514** is configured to process alarm data within a BMS associated with the BMS controller **500**. The alarm manager module **514** may further be configured to provide the alarm data to the visualization module **512**. Upon receiving the alarm data from the alarm manager module **514**, the visualization module **512** may display the alarm data via the alarm manager GUI **1100**. In one embodiment, the alarm manager GUI **1100** is accessed by selecting an alarm indicator, such as alarm indicator **708** described above. In other embodiments, the alarm manager GUI **1100** can be accessed in any of the GUIs described in FIGS. **7-10**. The alarm manager GUI **1100** may include an alarm summary display **1102** and an alarm manager interface **1104**. The alarm summary display **1102** can provide a general overview of the pending alarms within the BMS. In one embodiment, the alarm summary display **1102** can include a pending alarm status graphic **1106**. The pending alarm status graphic **1106** may display the total number of faults, as well as provide an indication as to the number of acknowledged faults and unacknowledged faults. The indication may be a basic text indication, a graphical indication, or a combination thereof. The alarm summary display **1102** may further include an alarm priority status graphic **1108**. The alarm priority status graphic **1108** may divide the current number of active faults into different priority levels. The alarm priority status graphic **1108** may use graphics to illustrate the distribution of faults by priority.

The alarm manager interface **1104** includes an alarm summary indicator **1110**, an actions menu selection box **1112**, a filter input **1114**, a sorting bar **1116** and a detailed fault display **1118**. The alarm summary indicator **1110** provides a quick indication of the number of outstanding alarms. In one embodiment, the alarm summary indicator **1118** may provide a color indication when there are unacknowledged alarms. For example, the alarm summary indicator **1118** may be displayed in red where there are unacknowledged alarms, yellow when there are only acknowledged alarms, and green when there are no pending alarms. The actions menu selection box **1112** can allow a user to access a menu of possible actions that can be performed. For example, the actions menu selection box **1112** may include options such as acknowledge, un-acknowledge, clear, and/or prioritize. However, other options are considered. The filter input **1114** allows a user to be able to filter the faults listed in the alarm summary indicator **1118**. In one embodiment, the filter input **1114** allows a user to filter the alarms in the alarm summary indicator **1118** using one or more filtering categories. Example filtering categories include priority, date, status, location, device, device name, zone, etc.

The sorting bar **1116** provides a heading for the alarm summary indicator **1118**, describing what each of the items in the alarm summary indicator **1118** describes. Example headings include status, new, priority, alarm type, alarm value, equipment type, equipment name, zone, date of alarm, etc. A user can sort the alarm summary indicator **1110** by selecting one of the heading in the sorting bar **1116**, which will organize the listed alarms according to the selected heading. The alarm summary indicator **1118** can provide data associated with each alarm. For example, the alarm summary indicator **1118** can provide status information, whether the alarm is "new," alarm priority, alarm type, alarm value, equipment type, equipment name, zone, date of alarm etc. By graphically displaying the alarm information, a user can quickly understand what component within the BMS is causing the alarm condition. In one embodiment, the alarm manager GUI **1100** can use the alarm summary indicator **1118** to display alarms from upstream equipment (i.e. equipment associated with a subsystem being viewed). In one embodiment, a flashing indicator can be provided in the "new" column, indicating that the alarm is new.

The alarm summary indicator **1118** can further include a selection box **1120** for each row (i.e. each alarm). A user can select the selection box **1120** associated with an alarm and subsequently select the actions menu selection box **1112** to perform a certain action on the selected alarm. In one example, the user can select as many selection boxes **1120** as desired to allow for bulk processing of alarms. In one example, the sorting bar **1116** include a select all box **1122** which can be selected by a user to allow for bulk actions to be taken on the listed alarms. A menu selection button **1124** may further be located on the alarm manager interface **1104** (or within the alarm manager GUI **1100** in general) allowing a user to select other display options. In one embodiment, the alarm manager GUI **1100** may group occurrences of alarms (i.e. group specific alarms together, regardless of occurrence time) so that all occurrences of a particular alarm may be viewed and/or managed together. Allowing group managing of the alarms may allow for quick clearing of nuisance alarms.

In one embodiment, the menu selection button **1124** may allow a user to generate an alarm report. FIG. **12** illustrates an exemplary alarm report **1200**. The alarm report **1200** can include information about each of the pending alarms. As shown in the alarm report **1200**, the information can include: alarm priority, "new" status, alarm type, trigger value, equipment type, equipment name, space (location), occurrence time, etc. In one embodiment, the report provides the same information as shown in the alarm manager interface **1104**, described above. In other embodiments, a user may be able to customize the alarm report **1200** to provide more or less information. In some embodiment, the alarm report **1200** may output statistics associated with one or more of the alarms.

Turning now to FIG. **13** a scheduling overview GUI **1300** is shown, according to one embodiment. The scheduling overview GUI **1300** can display multiple schedules associated with a BMS. In one embodiment, the scheduling module **516** may be configured to generate one or more schedules based on an input from a user. The scheduling module **516** may further be configured to provide the scheduling data to the visualization module **512**, which can then visualize the schedule for a user. For example, the scheduling overview GUI **1300** may display schedules associated with a space, such as an entire facility, building, floor, room and/or individual systems or equipment associated with the space. The schedules may include operations, setpoints, or other information associated with equipment or systems associated with the space. Example operations may include damper positions, AHU and VAV operations, shade positions, lighting operations (e.g. on or off), and the like. Example setpoints may include temperature setpoints, humidity setpoints, motor speeds, fan speeds, etc.

The scheduling overview GUI **1300** can include a schedule list interface **1302**. The schedule list interface **1302** can list all of the pending schedules associated with a given facility, building or floor. Further, the schedule list interface **1302** can further display the actions associated with each schedule over a period of time. In one example, the scheduling overview GUI **1300** can include a date selection interface **1304**. The date selection interface **1304** can allow a user to view all schedules associated with the selected date on the schedule list interface **1302**. In one embodiment, the date selection interface **1304** can be used to show a schedule associated with all or a portion of the BMS in the future or in the past. The scheduling overview GUI **1300** can further include a filter menu button **1306**. The filter menu button **1306** can allow a user to filter the schedules displayed in the schedule list interface **1302**.

Turning now to FIG. **14**, a location schedule GUI **1400** is shown, according to one embodiment. In one embodiment, the location schedule GUI **1400** is accessed by selecting one of the schedules listed in the scheduling overview GUI **1300**. Alternatively, a user may access the location schedule GUI **1400** by searching for the specific location using a search function, such as that described in FIG. **7**, above. For example, the user may type "Floor **1**" into a search box, select the proper floor, and then view the schedule. In one example, the location schedule GUI **1400** can include a schedule view **1402**. In one embodiment, the schedule view **1402** can be displayed as a weekly calendar view. However, other views are considered, such as a daily view, a monthly view, or a yearly view. The schedule view **1402** can provide details regarding the schedule. For example, the schedule view **1402** can indicate when a given location is planned on being occupied or not occupied. In one embodiment, the status of the given location in the schedule can be color coded. Similar to the scheduling overview GUI **1300**, the location schedule GUI **1400** may include a date selection interface **1404**, which can allow a user to input a date directly into the location schedule GUI **1400**. In one embodiment, the date selection interface **1404** allows a user to select a date in the future or in the past to view the associated schedule for the selected location. The schedule view **1402** can further include a schedule detail interface **1406**. In one embodiment, the schedule detail interface **1406** allows a user to select the level of detail desired to be displayed in the schedule view **1402**. For example, a user can select to view the schedule as an effective schedule, or as a breakout schedule using the schedule detail interface **1406**. The schedule detail interface **1406** can further allow for additional detail to be selected within a schedule type. For example, where a user selects to view the schedule as a breakout schedule, the user may further be able to select options such as whether to view the breakout schedule as a weekly schedule, whether to show exceptions to the schedule, or whether to show one or more default commands using the schedule detail interface **1406**.

In some embodiments, the location schedule GUI **1400** can further include location selection tree **1408**. The location selection tree **1408** may allow for a user to further find schedules associated with progressively lower levels of the BMS. For example, the schedule displayed in FIG. **14** is related to "Floor **1**." Using the location selection tree **1408**, a user can then select rooms located on "Floor **1**," and thereby view their associated schedules, as will be described in more detail below.

Turning now to FIG. **15**, an room effective schedule GUI **1500** is shown, according to one embodiment. Similar to the location schedule GUI **1400** described above, the room effective schedule GUI **1500** can include a schedule view **1502**, a date selection interface **1504** and a schedule detail interface **1506**. The schedule view **1502**, the date selection interface **1504** and the schedule detail interface **1506** may have the same functionality as the schedule view **1402**, the date selection interface **1404** and the schedule detail interface **1406** described above. For example, the schedule view **1502** may show the schedule for the selected room in a calendar format. In one embodiment, the room effective schedule GUI **1500** includes a disable button **1508**. The disable button **1508** can override the schedule for the selected space (e.g. room, floor, building or campus). In one example, selecting the disable button **1508** may bring up a menu allowing a user to select options associated with overriding the schedule. For example, the user may be able to override the schedule completely, for a set period of time, for a user defined period of time, for certain calendar days, etc. As shown in FIG. **15**, the schedule view **1502** is displaying an effective schedule, as selected in the schedule detail interface **1506**.

Turning now to FIG. **16**, a room breakout schedule GUI **1600** is shown, according to one embodiment. Similar to the room effective schedule GUI **1500** described above, the room breakout schedule GUI **1600** can include a breakout schedule view **1602**, a date selection interface **1604**, a schedule detail interface **1606** and a disable button **1608**. The breakout schedule view **1602**, the date selection interface **1604**, the schedule detail interface **1606**, and the disable button **1608** may have the same functionality as the schedule view **1502**, the date selection interface **1504**, the schedule detail interface **1506**, and the disable button **1508** as described above. The breakout schedule view **1602** can display the same schedule as shown in FIG. **14** in breakout form. As shown in the breakout schedule view **1602**, the weekly schedule is shown, along with exceptions and default commands, as selected in the schedule detail interface **1606**. This can provide a detailed view of a room schedule to a user quickly allowing the user to quickly determine if changes are necessary.

Turning now to FIG. **17**, a schedule modification GUI **1700** is shown. In one embodiment, the schedule modification GUI **1700** can be accessed by a user selecting an event or schedule within a schedule view, such as those described in FIGS. **13-16**, above. The schedule modification GUI **1700** may allow a user to modify a schedule for a specific location, such as a building, a floor, or a room. The schedule modification GUI **1700** includes a schedule view interface **1702**. The schedule view interface **1702** includes a number of schedule edit buttons **1704**. The schedule edit buttons **1704** may be associated with each day of the week shown in the schedule view interface **1702**. However, in some embodiments, there may be a schedule edit button **1702** associated with each listed schedule displayed in the schedule view interface **1702**. Selecting a schedule edit button **1704** can allow a user to modify the selected schedule using a schedule edit interface **1706**. The schedule edit interface **1706** can allow a user to select a start and stop time for one or more values for each schedule. In one example, such as where the schedule is a building schedule, a user may be able to select start and stop times that the building is either expected to be occupied or unoccupied. The ability to quickly modify a schedule for a building is beneficial where the building experiences an unplanned change in occupancy. For example, when the building may be unoccupied due to weather, such as a snow emergency. By allowing the schedule to be modified on a building level, the schedules associated with rooms and floors within the building being occupied or unoccupied can be automatically modified based on the building schedule. The schedule modification GUI **1700** may further include an Add Event button **1707**. The Add Event button **1707** may allow a user to add a new event to an existing schedule. In one embodiment, the user may add a new event after selecting the Add Event button **1707** by entering the event information into the schedule edit interface **1706**. In some examples, additional modification selections may be available in the schedule edit interface **1706** when a new event is added, such as an ability to name the event, as well as setting certain parameters associated with the new event. For example, parameters associated with the new event may include priority, downstream equipment affected, etc. Once the schedule has been modified, a user can select the next button **1708**. However, if the user does not wish to modify the schedule, the user can select the cancel button **1710**.

Turning now to FIG. **18**, a process **1800** for processing a schedule modification or creation request is shown, according to some embodiments. In one embodiment, the process **1800** is processed by the BMS controller **500**, and specifically by the scheduling module **516**. However, other controllers or devices may be used to enact the process **1800**. At process block **1802**, the BMS controller **500** receives a scheduling input. The scheduling input may be provided using the user interface **504**. In other embodiment, the scheduling input may be provided via the remote user interface **528**. As described above, the scheduling input may be input via the schedule modification GUI **1700**. The scheduling input may be a request to initiate a new schedule, to add an event to a current schedule, or to modify an existing schedule, as described above. The scheduling input may include multiple data elements, such as effective period elements, weekly schedule elements, exception schedule elements, calendar entries elements, default schedule command elements, or other elements.

At process block **1804**, the scheduling module **516** and/or the BMS controller **500** extracts the schedule elements from the received schedule input. As stated above, the schedule elements may include effective period elements, weekly schedule elements, exception schedule elements, calendar entries elements, default schedule command elements, or other elements. These elements are described in more detail in regards to FIG. **19**, discussed below. In some embodiments, the scheduling module **516** and/or the BMS controller **500** can parse the received scheduling input to extract the scheduling elements. In other embodiments, one or more plug-ins may be installed on the BMS controller **500** and used by the scheduling module **516** to extract the data from the scheduling input. Plug-ins can allow multiple scheduling systems to potentially be used by the user to establish the schedule. For example, some plug-ins may be used to allow for the scheduling module **516** to extract data from well-known scheduling systems, such as Microsoft® Outlook®.

Once the scheduling elements have been extracted at process **1804**, the extracted scheduling elements are converted into individual data objects at process block **1806**. In one embodiment, the extracted elements are converted into individual data objects that are data objects readable by a BMS system. For example, the individual data objects may be BACnet data objects. In some embodiments, the individual data objects are BACnet command objects. The BACnet command objects may be used to control the operation of one or more BMS devices based on the schedule.

Turning briefly now to FIG. **19**, a block diagram illustrating a system **1900** for converting the extracted schedule elements into data objects is shown, according to one embodiment. The system **1900** is one example system for converting schedule elements into data objects. However, other methods and systems for converting schedule elements into data objects are also contemplated. In one embodiment, the system **1900** is associated with the scheduling module **516**. The systems shows an effective period element **1902**, a weekly schedule element **1904**, an exception schedule element **1906**, a calendar entry element **1908**, and a default schedule command element **1910**. The schedule elements **1902-1910** are inputs to a schedule element conversion logic block **1912**, which outputs one or more data objects **1914**, as described above.

The effective period element **1902** determines when a given schedule is active (e.g. over what time period). The effective period element **1902** may include a start date and an end date. In other examples, the effective period element **1902** may include ranges of activity (i.e. days/months/years, etc.) The effective period element **1902** may also include times of a day in which the schedule is active. The weekly schedule element **1904** may include a weekly schedule which may drive what actions are taken (e.g. when a command object is sent, and at what value), and when the weekly schedule may cede control back to a default schedule command element **1910**. The weekly schedule element **1904** may be similar to the effective period element **1902**, as the weekly schedule element **1904** may have variations in the schedule based on the day of the week. However, the weekly schedule element **1904** may further include instructions to specify the start time and end time for a given schedule command or value.

The exception schedule elements **1906** are transient entities denoting non-scheduled start points and end points for one or more values or commands associated with a schedule. Generally the exception schedule elements **1906** are deleted after they have expired (e.g. after the end point date or time). In some embodiments, the exception schedule elements **1906** are deleted after a given period of time has passed since the exception schedule element **1906** expires. For example, the exception schedule elements **1906** may be deleted one calendar month after the expiration time. In other examples, the exception schedule elements **1906** may be stored indefinitely. The exception schedule elements **1906** may include default entities and calendar reference entities, as well as other exception schedule entities. The default entities may be associated with default values or commands associated with the exception schedule element **1906**. The default entities may include multiple pieces of information, including day/date information, a list of start time/value pairs, an associated precedence (e.g. priority of the exception relative to other exceptions for the schedule), as well as other default information. The calendar reference entities may allow a user to use a "calendar" object to set the dates for the exception schedule elements **1906**. The calendar objects may define the dates that the exception is in effect. Each date, would have a list of "events" or start time/value pairs for the schedule to execute. Similarly, calendar referenced exceptions would also have precedences. In some embodiments, the calendar entities may refer to a "global calendar." The "global calendar" may relate to a series of entries in a calendar that are defined externally (e.g. by another object, potentially on a different processing engine).

The calendar entries elements **1908** allow a user to use a calendar object to set the dates for a scheduled action. For example, the use may use a calendar application to set certain dates for actions to occur (e.g. set values or commands). Finally, the default schedule command elements **1910** are commands that are generated when a scheduled action in an exception schedule or weekly schedule is no longer in effect. This could simply be a release of a scheduled command, or could be a new write to the scheduled items. In some embodiments, the default schedule command elements **1910** are predefined commands or values for use in the BMS. In other embodiments, the default schedule command elements may be set by a system administrator or a supervisory system.

The schedule element conversion logic block **1912** is configured to convert the extracted schedule elements **1902-1910** to one or more data objects **1914**. In one embodiment, the schedule element conversion logic block **1912** utilizes a precedence calculation output to generate the data objects **1914** associated with an "effective schedule." The effective schedule is a series of events (e.g. a potential change in what is currently happening in the system). The schedule element conversion logic block **1912** may apply rules to set the precedences of events. For example, an event causing an effective period to become disabled may be the highest precedence event. An exception event (e.g. an exception schedule element **1906**) may always have a higher precedence than a weekly schedule event. An exception event (e.g. an exception schedule element **1906**) may have a defined precedence, which may be compared to a precedence of a conflicting exception event. An event can end either with the start of a different event or a passive stop event (e.g. scheduled end). When any two events have equal precedence using the above rules, the first event may be considered to have higher precedence. The above rules are for example purposes, and it is understood that additional or different rules may be used to set a precedence order of events.

The schedule element conversion logic block **1912** may then generate one or more data objects **1914**. In one embodiment, the data objects **1914** are BACnet objects that can be transmitted over a BACnet network. However, the data objects **1914** may be other object types, as applicable. As described above, the data objects **1914** may include value change objects and/or command objects.

Returning now to FIG. **18**, once the scheduling elements have been converted into individual data objects at process block **1806**, the schedule may be previewed and confirmed by a user. Turning now to FIG. **20**, a schedule modification preview GUI **2000**, according to one embodiment. The schedule modification preview GUI **2000** may provide a user with a schedule view **2002** including the modification or addition made to a schedule using the schedule modification GUI **1700**. In one embodiment, the schedule modification preview GUI **2000** is generated when a user selects the next button **1708** in the schedule modification GUI **1700**. The schedule modification preview GUI **2000** includes a previous button **2004**, which may allow a user to return to a schedule modification GUI **1700** to make additional modification to the schedule. Further, the schedule modification preview GUI **2000** may include a cancel button **2006** which will exit the schedule modification preview GUI **2000** without saving any changes made to the schedule, as described above. The schedule modification preview GUI **2000** may also include a save button **2008** which can be selected to save the schedule displayed in the schedule view **2002**. In some embodiment, after the user selects the save button **2008**, a confirmation GUI interface may be generated to verify that the user wishes to execute the schedule change. The user may then confirm the schedule.

Returning now to FIG. **18**, once the user confirms the schedule, the revised schedule may be executed at process block **1810**. For example, the BMS controller **500** may communicate one or more data objects (e.g. value changes or commands) to associated equipment or devices within the BMS.

Turning now to FIG. **21**, a potential problems interface GUI **2100** is shown, according to one embodiment. In one embodiment, the problem detection module **518** is configured to detect potential problems within a BMS associated with the BMS controller **500**. The problem detection module **518** may further be configured to provide the potential problem information to the visualization module **512**, which can generate the potential problems interface GUI **2100**. The potential problems interface GUI **2100** can allow a user to select a specific space, such as a facility, building, floor, room or system and immediately see any potential issues associated with the selected space. Potential problems can include alarms, operator overrides, occupant complaints ("Hot" or "Cold" calls), etc. As shown in FIG. **21**, the potential problems interface GUI **2100** is viewing potential problems for a facility. A potential problem areas interface **2102** can display possible problem areas, along with information about the potential problem. Example information can include a value of the potential problem, what equipment is associated with the potential problem, and what space may be affected (e.g. floor or room). The potential problems interface GUI **2100** can further include a location navigation tree **2104**. The location navigation tree **2104** may allow for a user to further find potential problems associated with progressively lower levels of the BMS.

Turning to FIG. **22**, a floor-level potential problems interface GUI **2200** is shown. In one embodiment, the floor-level potential problems interface GUI **2200** includes a floor interface **2202**. The floor interface **2202** may provide a user with a visual indication of potential problem area. In one embodiment, the floor interface **2202** provides a user with visual indication of potential problem areas by color coding the individual spaces on the floor. For example, front lobby space **2204** may be highlighted in red to illustrate that there is a potential problem. In some examples, a user may wish to search for a particular space within a facility, building or floor. As shown in FIG. **22**, a user can search for a particular space using the search bar **2206**. For example, the user, searching for room **2**, may enter "room" into the search bar **2206**, and then select "room **2**" from the list of options provided.

Turning to FIG. **23**, a floor equipment service space interface GUI **2300** is shown, according to one embodiment. In one embodiment, the equipment service space module **520** is configured to determine equipment associated with a given space within a BMS associated with the BMS controller **500**. The equipment service space module **520** may further be configured to provide the equipment service space information to the visualization module **512**, which can generate the floor equipment service space interface GUI **2300**. In further embodiments, the equipment service space module **520** may be in communication with the association module **524**. The association module **524** may provide the equipment service space module **520** with equipment associated with one or more spaces in the BMS. The floor equipment service space interface GUI **2300** includes an equipment serving space interface **2302**, a potential problem areas interface **2304**, an equipment summary interface **2306** and a navigation tree **2308**. The equipment serving space interface **2302** may provide details regarding the each piece of equipment servicing a particular space. In FIG. **23**, the space is a floor. The equipment serving space interface **2302** can include current parameters and/or a status of each piece of equipment serving the selected space. For example, equipment serving space interface **2302** shows AHU-1 as a piece of equipment serving the selected space, and displays parameters associated with the "Discharge Air Temperature," the "Discharge Air Temperature Setpoint," and the "Effective Discharge Air Setpoint." The equipment service space interface **2302** can include a filter button **2310**. The filter button **2310** can be used to filter what information is shown in the equipment serving space interface **2302**. For example, the filter button **2310** may allow a user to filter the equipment serving space interface **2302** to only show certain types of equipment serving the selected space, such as all air handling units. In other examples, the filter button **2310** may allow a user to filter the equipment serving space interface **2302** to only show certain data associated with each of the different pieces of equipment serving the selected space.

The potential problem areas interface **2304** of the floor equipment service space interface GUI **2300** may display all the potential problems associated with the selected space. In one embodiment, the potential problems are the same types of potential problems described in regards to FIG. **21**, discussed above. The potential problem areas interface **2304** may include a problem filter input **2312**. The problem filter input **2312** can allow a user to filter the potential problems listed in the potential problem areas interface **2304**. Example filter parameter can include priority, type, associated equipment, space affected, parameter value, etc. The equipment summary interface **2306** may provide a brief summary of each piece of equipment serving the selected space. In one embodiment, selecting a piece of equipment listed in the equipment summary interface **2306** causes the selected piece of equipment, and its related information, to be displayed in the equipment serving space interface **2302**. The equipment summary interface **2306** can further include a device type selection input **2314**. The device type selection input **2314** can allow a user to filter the equipment summary interface **2306** to display only certain types of equipment. For example, a user may filter the equipment summary interface **2306** to show only heating equipment, cooling equipment, air handling equipment, lighting equipment, etc. Finally, the navigation tree **2308** may allow for a user to select other spaces associated with progressively lower levels of the BMS.

Turning now to FIG. **24**, a room equipment serving space interface GUI **2400** is shown, according to one embodiment. In one embodiment, the room is selected using a navigation tree **2402**, which may be the same as navigation tree **2308**, discussed in FIG. **23** above. The room equipment serving space interface GUI **2400** may include an equipment serving space interface **2404**. The equipment serving space interface **2404** may display each piece of equipment serving the selected space (i.e. room **2**), as shown in FIG. **24**. The equipment serving space interface **2404** may further display details about each piece of equipment, similar to the equipment service space interface GUI **2300** described above.

Turning to FIG. **25**, an equipment serving space summary interface GUI **2500** is shown, according to one embodiment. The equipment serving space summary interface GUI **2500** includes an equipment summary interface **2502**. The equipment summary interface **2502** can provide a list of all equipment serving a selected space (e.g. building, floor, room, etc.). In one embodiment, the equipment summary interface **2502** includes a sorting bar **2504**. The sorting bar **2504** can allow a user to sort the listed equipment information by a variety of categories listed in the sorting bar **2504**. Example categories can include: equipment name, space/location of equipment, temperature (or other applicable parameters), equipment state, equipment set-point, minimum set-points, maximum set-points, set-point differential, location occupancy mode, etc. Other categories are additionally considered. The equipment summary interface **2502** can further include a device filter button **2506**. The device filter button **2506** may allow a user to select the type of device(s) to be displayed on the equipment summary interface **2502**. For example, a user may only want to see what VAVs are associated with a particular floor.

Turning now to FIG. **26**, a data trend GUI **2600** is shown, according to one embodiment. In one embodiment, the data analytics module **522** is configured to analyze data associated with one or more pieces of equipment within a BMS associated with the BMS controller **500**. The data analytics module **522** may further be configured to provide analyzed data to the visualization module **512**, which can generate the data trend GUI **2600**. In one example, the data analytics module **522** is configured to analyze the data from one or pieces of equipment in the BMS to generate one or more trends. In one embodiment, the data trend GUI **2600** is generated when a user selects a trend data icon, such as the trend data icon **712** discussed in FIG. **7**, above. The data trend GUI **2600** can provide trend data for one or more selected systems or pieces of equipment in the BMS. The data trend GUI **2600** may include a trend data interface **2602** and an equipment activity window **2604**. The trend data interface **2602** can provide graphical trend data of a particular piece of equipment or system. In one embodiment, the trend data is real-time data. The data can also be historical data, or a combination of historical data and real-time data. The trend data interface **2602** can include a data selection toolbar **2606**. The data selection toolbar **2606** can allow a user to select what parameters to display on the trend data interface **2602**. In one example, the trend data interface **2602** may allow a user to custom select the time scale, sampling rate, and/or other parameters of the trend data to generate a custom trend. The equipment activity window **2604** may provide a user with details related to the selected equipment or system, such as current parameters, equipment data (name, set-points, etc.), alarms associated with the equipment, equipment status, etc.

Configuration of Exemplary Embodiments

The construction and arrangement of the systems and methods as shown in the various exemplary embodiments are illustrative only. Although only a few embodiments have been described in detail in this disclosure, many modifications are possible (e.g., variations in sizes, dimensions, structures, shapes and proportions of the various elements, values of parameters, mounting arrangements, use of materials, colors, orientations, etc.). For example, the position of elements can be reversed or otherwise varied and the nature or number of discrete elements or positions can be altered or varied. Accordingly, all such modifications are intended to be included within the scope of the present disclosure. The order or sequence of any process or method steps can be varied or re-sequenced according to alternative embodiments. Other substitutions, modifications, changes, and omissions can be made in the design, operating conditions and arrangement of the exemplary embodiments without departing from the scope of the present disclosure.

The present disclosure contemplates methods, systems and program products on any machine-readable media for accomplishing various operations. The embodiments of the present disclosure can be implemented using existing computer processors, or by a special purpose computer processor for an appropriate system, incorporated for this or another purpose, or by a hardwired system. Embodiments within the scope of the present disclosure include program products comprising machine-readable media for carrying or having machine-executable instructions or data structures stored thereon. Such machine-readable media can be any available media that can be accessed by a general purpose or special purpose computer or other machine with a processor. By way of example, such machine-readable media can comprise RAM, ROM, EPROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to carry or store desired program code in the form of machine-executable instructions or data structures and which can be accessed by a general purpose or special purpose computer or other machine with a processor. Combinations of the above are also included within the scope of machine-readable media. Machine-executable instructions include, for example, instructions and data which cause a general purpose computer, special purpose computer, or special purpose processing machines to perform a certain function or group of functions.

Although the figures show a specific order of method steps, the order of the steps may differ from what is depicted. Also two or more steps can be performed concurrently or with partial concurrence. Such variation will depend on the software and hardware systems chosen and on designer choice. All such variations are within the scope of the disclosure. Likewise, software implementations could be accomplished with standard programming techniques with rule based logic and other logic to accomplish the various connection steps, processing steps, comparison steps and decision steps.

What is claimed is:

1. A building management system (BMS) interface system, comprising:

a user interface;

one or more processors; and

one or more non-transitory computer-readable media storing instructions that, when executed by the one or more processors, cause the one or more processors to perform operations comprising:

displaying a graphical scheduling interface on the user interface;

receiving a scheduling input from the user interface;

extracting one or more scheduling elements from the received scheduling input, the scheduling elements comprising an indication of a space or equipment to which the scheduling elements apply and a desired state or condition of the space or equipment;

automatically identifying one or more points that correspond to the space or equipment indicated by the scheduling elements that are used to operate the equipment in order to achieve the desired state or condition, the one or more points identified using stored relationships between the points and the corresponding space or equipment;

automatically generating one or more BMS data objects for each of the one or more points based on the scheduling input, the BMS data objects defining, for each of the one or more points, one or more point values and a time at which the point is to be set to each of the one or more point values;

updating the graphical scheduling interface displayed on the user interface; and

executing one or more scheduling instructions based on the BMS data objects, wherein the scheduling instructions are associated with operation of one or more BMS devices and cause each of the one or more points to be set to a corresponding point value at a corresponding time.

2. The system of claim **1**, wherein the BMS data objects are BACnet data objects.

3. The system of claim **1**, wherein the graphical scheduling interface displays one or more operations associated with the BMS devices.

4. The system of claim **1**, wherein the graphical scheduling interface displays a schedule associated with one or more of a space, a date, or piece of equipment.

5. The system of claim **1**, wherein the graphical scheduling interface is configured to allow a user to override a defined schedule using the user interface.

6. The system of claim **5**, wherein the defined schedule may be one of overridden permanently, overridden for a predefined period of time, and overridden for a user defined period of time.

7. The system of claim **1**, wherein the processor is further configured to display a breakout schedule interface on the user interface, wherein the breakout schedule interface is configured to display a selected schedule comprising a schedule for a predefined period of time, a list of exceptions, and a list of default commands for the schedule.

8. The system of claim **1**, wherein the processor is further configured to display an equipment summary interface, wherein the equipment summary interface displays a list of equipment, and parameters associated with the equipment, for a given space.

9. The system of claim **8**, wherein the processor is further configured to automatically determine which equipment is associated with the given space based on one or more predetermined relationship parameters associated with the equipment and the space.

10. The system of claim **8**, wherein the processor is further configured to generate trend data for a selected piece of equipment displayed in the equipment summary interface, wherein the equipment is selected by a user using the user interface.

11. A method for scheduling one or more building management system (BMS) operations for a space, the method comprising:

receiving a scheduling input from a user at a processor;

extracting one or more scheduling elements from the scheduling input, the scheduling elements comprising an indication of a space or equipment to which the scheduling elements apply and a desired state or condition of the space or equipment;

automatically identifying one or more points that correspond to the space or equipment indicated by the scheduling elements and that are used to operate the equipment in order to achieve the desired state or condition, the one or more points identified using stored relationships between the points and the corresponding space or equipment;

automatically generating one or more BMS data objects for each of the one or more points based on the scheduling input, the BMS data objects defining, for each of the one or more points, one or more point values and a time at which the point is to be set to each of the one or more point values;

transmitting a schedule confirmation request to the user;

receiving a schedule confirmation from the user at the processor; and

executing a confirmed schedule, wherein executing the confirmed schedule comprises operating one or more BMS devices based on the BMS data objects and causing each of the one or more points to be set to a corresponding point value at a corresponding time.

12. The method of claim **11**, wherein the scheduling input is one or more of an input to generate a new schedule and an input to modify an existing schedule.

13. The method of claim **11**, wherein the BMS data objects are BACnet data objects.

14. The method of claim **11**, wherein the processor is configured to automatically associate one or more BMS devices with the space based on one or more pre-defined parameters of the one or more BMS devices.

15. The method of claim **11**, further comprising generating a preview of the schedule prior to receiving the schedule confirmation.

16. A building management system (BMS) graphical user interface system, comprising:

a user interface device;

one or more processors; and

one or more non-transitory computer-readable media storing instructions that, when executed by the one or more processors, cause the one or more processors to perform operations comprising:

automatically associating one or more BMS devices with a space;

displaying a graphical scheduling interface for the space on the user interface device, wherein the graphical scheduling interface is configured to display an operational schedule for the one or more BMS devices associated with the space;

receiving a scheduling input from the user interface device, wherein the scheduling input is one of a new schedule request and a schedule modification request;

extracting one or more scheduling elements from the received scheduling input, the scheduling elements comprising an indication of a space or equipment to which the scheduling elements apply and a desired state or condition of the space or equipment;

automatically identifying one or more points that correspond to the space or equipment indicated by the scheduling elements and that are used by the processors to operate the equipment in order to achieve the desired state or condition, the one or more points identified using stored relationships between the points and the corresponding space or equipment;

automatically generating one or more BMS data objects for each of the one or more points based on the scheduling input, the BMS data objects defining, for each of the one or more points, one or more point values and a time at which the point is to be set to each of the one or more point values, wherein the BMS data objects are data objects capable of being executed by the processors; and executing one or more scheduling instructions based on the BMS data objects, wherein the scheduling instructions are associated with operation of one or more BMS devices and cause each of the one or more points to be set to a corresponding point value at a corresponding time.

17. The system of claim **16**, wherein the space is one or more of a campus, a building, a portion of a building, or a room within a building.

18. The system of claim **16**, wherein the BMS data objects are BACnet data objects.

19. The system of claim **16**, wherein the processor is further configured to display an equipment summary interface, wherein the equipment summary interface displays a list of equipment and parameters associated with the equipment for a given space.

20. The system of claim **19**, wherein the processor is further configured to generate and display trend data for a selected piece of equipment displayed in the equipment summary interface, wherein the equipment is selected by a user using the user interface device.

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